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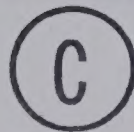
FACULTY OF AGRICULTURE

AN EVALUATION OF THE FEDERAL-PROVINCIAL

BEEF CATTLE RECORD OF PERFORMANCE

TESTING PROGRAM IN ALBERTA

by



KENNETH KARL PFANNMULLER

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ABSTRACT

Analysis of the records of 39 Hereford and 14 Angus herds enrolled on the Federal-Provincial Beef Cattle Record of Performance Testing Program in Alberta from 1955 to 1966 indicated a lack of improvement

in the production traits in these herds.

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The weighted regression over years of the performance of the 43 herds. The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "An Evaluation of the Federal-Provincial Beef Cattle Record of Performance Testing Program in Alberta" submitted by Kenneth Karl Pfannmuller, B. Sc., in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

Analysis of the records of 29 Hereford and 14 Angus herds enrolled on the Federal-Provincial Beef Cattle Record of Performance Testing Program in Alberta from five to 11 years indicated a lack of improvement in the production traits in these herds.

The weighted regression over years of the performance of the 43 herds for preweaning ADG, end-of-test conformation score, post-weaning ADG and weight-per-day of age showed that only the conformation traits had shown acceptable response. For males, for the four traits respectively, only three, eleven, six and three of the 43 herds showed a level of improvement that was significant ($P < 0.05$). For females, significant improvement occurred in two, eight, eight and five of the 43 herds for the four traits respectively.

Performance records on two lines of beef cattle from the University of Alberta Beef Cattle Breeding Project were analyzed to determine genetic trends in birth weight, adjusted 180-day weaning weight, 365-day weight and 540-day weight. In all but the birth weight trait, a consistent level of improvement occurred in both sexes. Males were not weighed at 540 days of age.

The analysis of performance records in two commercial herds showed a marked degree of improvement in weight-per-day of age at weaning due to the influence of selection and crossbreeding.

Among the factors that contributed to the failure of many of the herds to make improvement in the weight traits were placing too much

emphasis on conformation score, declining creepfeeding trend over years, use of the same sire for many years, use of sires that were not performance tested, rapid expansion of cattle herds, selection for breed characteristics with no economic value and insufficient number of years of performance testing.

It was recommended that intensive consulting services on the use of records be provided and that the indexes of sire and dam be included on worksheets and in summaries.

A periodic evaluation of the progress of each participant would be desirable in order to avert any serious trends in the performance of their cattle.

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INTRODUCTION

Improvement can generally be made in all classes of domestic animals by the use of a rigidly executed selection program. Selection is the major force that changes the genetic makeup of a population. Genetic variation within a population is necessary for an effective selection program.

The Alberta section of the Federal-Provincial Beef Cattle Performance Testing Program was inaugurated in 1959. This program provided an opportunity for the purebred beef cattle breeder to evaluate the performance of individual animals within his own herd. The four traits that are considered under this beef cattle improvement program are (1) preweaning average daily gain, (2) post-weaning average daily gain, (3) end-of-test conformation score and (4) weight-per-day of age taken at the end of the post-weaning gain test.

In recent years, there has been much speculation by extension livestock specialists, animal geneticists and beef cattle producers concerning the impact that the Record of Performance (ROP) Program has had on the improvement of beef cattle herds in Alberta. The purpose of this study is to determine if any significant trends in performance have occurred as a result of this program, to discuss the significance of these trends, and to suggest possible ways to increase the effectiveness of the program as a tool in the improvement of production traits in beef cattle.

LITERATURE REVIEW

I. The History of Selection

Selection in one form or another has been common in all classes of domestic animals for many decades. With the work of Robert Bakewell and his contemporaries in England during the late 1700's, breeds were started and the use of the show-ring and of records began as a means of developing farm animals along special use lines (Lasley, 1963). As a result of this foundation work, breeds of cattle were developed specifically for their ability to produce either meat or milk. The need to constantly strive for improvement in farm animals by the use of selection cannot be over-emphasized if the objectives originally set up during the development of animals for special uses are to be maintained and strengthened.

II. Non-Genetic Factors Affecting Preweaning Performance in Beef Cattle

Expected genetic change from selection is increased by accurately adjusting for various environmental factors which are readily identifiable in beef cattle improvement programs. The major non-genetic factors that influence the preweaning gains of beef calves are age of dam, sex of calf, month of birth, year of birth, age of calf at time of weaning and the management practices within the herd.

A. Age of Dam Effects

It is well documented that there are consistent differences occurring in weaning weights of beef calves that can be explained entirely by differences in the ages of the cows mothering the calves.

If no age of dam adjustments were made at weaning, the genetic worth of calves from younger and older cows would be underestimated.

Botkin and Whatley (1953) reported adding 35 and 15 lb. to the weaning weights of calves from three- and four-year-old cows respectively. In this study, cows five years old and older produced calves with similar weaning weights and, thus, were considered as mature.

Koch and Clark (1955) found weaning weight adjustment factors for age of dam to be 41, 18, 6, 0, 3, 6, 12 and 24 lb. for three- to 10-year-old cows respectively. This study concerned 5,952 Hereford calves born during the period 1926 to 1951.

Clum et al. (1956) reported adjusting calf weights to a mature dam equivalent by adding 63, 35, 12, 5, 3, 8, 18, 34, 53 and 53 lb. to cows aged 1, 2, 3, 4, 11, 12, 13, 14, 15 and 16 years respectively in calf growth data collected over a 25-year period.

Marlowe and Gaines (1958) reported results of a study involving 4,166 non-creepfed calves and 2,007 creepfed calves in 44 Angus, 19 Hereford and three Shorthorn herds. Age of dam adjustment factors for 2-, 3-, 4-, 5-, 6 to 10-, 11 to 13- and 14 plus-year-old cows were 1.20, 1.10, 1.06, 1.03, 1.00, 1.05 and 1.15 respectively for non-creepfed calves and 1.14, 1.08, 1.03, 1.01, 1.00, 1.03 and 1.08 respectively for creepfed calves.

Reporting on 2,528 calves of various breeds and crosses, Reynolds et al. (1958) found that calves from two-, three- and four-year-old cows were 67, 35 and 15 lb. lighter respectively than calves born from dams five to twelve years of age. Correction factors for cows 2, 3, 4,

11 and 12 years of age were 1.09, 1.09, 1.05, 1.03 and 0.06 respectively using data from records of grade Hereford and Angus herds at various experimental stations throughout Mississippi (Meade et al. 1959).

Brown (1960) reported that, in one Hereford herd and one Angus herd under fairly high levels of management, 180-day weaning weights for Hereford calves were adjusted for age of dam as follows: +36, +17, +6, -8, 0, -6, -28 and -17 lb. for Hereford cows in their first to eighth lactations respectively. Adjustment factors for the Angus herd were +14, +2, -9, -6, 0, -10, -33 and -9 lb. for cows of the same ages. A second Angus herd under a rather low level of management indicated a very different adjustment schedule. In this herd, for cows in their first to eighth lactations (two to nine years of age) respectively, adjustment factors were as follows: +64, +36, +17, +22, 0, -9, 0 and +18 lb. These data indicated the need for consideration of age of calf and system of management in the standardization of calf weight records for age of dam. The development of correction factors for use under systems of management and environmental conditions similar to those under which they are to be applied are indicated by this study.

Holzman (1960) recommended the addition of 70, 35, 20, 10, 20, 25 and 40 lb. to the weaning weight of calves out of 2-, 3-, 4-, 9-, 10-, 11- and 12-year-old dams respectively to adjust for age of dam effects. One hundred and eighty-day weaning weight adjustment factors for age of dam from three to 10+ years of age were found to be +30, +17, +5, 0, -1, -3, -1 and +5 kg. in another study (Brinks et al. 1962).

Marlowe (1962) summarized over 21,000 records accumulated during the period 1953 through 1959 by age, month of birth, sex of calf and age of dam in the Virginia Beef Cattle Improvement Association Performance Testing Program using growth adjustment factors based on a study by Marlowe and Gaines (1958). He reported influence of age of dam on preweaning average daily gain as shown in Table 1. Growth of the calves increased as the age of the cows increased up to seven years. The level of calf growth remained the same through 10 years among the Angus cows and through 11 years before dropping off among the Hereford cows. The number of Shorthorn calves was too small to draw any definite conclusions but they appeared to follow the pattern of the other two breeds.

Lawson and Peters (1964) reported age of dam adjustment factors for calf weaning weight of 72, 37, 18 and 9 lb. for 2-, 3-, 4- and 9-year-old cows respectively in 219 Hereford and Highland calves and their reciprocal crosses. Brahman by Angus crossbred calves for three-year-old dams were 37 lb. lighter at 180 days and those from four-year-old dams were 15 lb. lighter at 180 days than calves from dams five years old and older (Vernon et al. 1964).

Burgess and Bowman (1965) reported on a study of 1,372 Hereford bull calves on the Ontario Advanced Registry Policy. It was found that calves from two- and three-year-old cows were 34.3 and 13.5 lb. lighter respectively than the average of all dams. Cows eight years old and older were found to wean calves that were 13.5 lb. above the average for all cows. This was explained by the older cows having been subjected to the culling process for a longer period of time. These

Table 1. Influence of age of dam on preweaning average daily gain
in both creepfed and non-creepfed beef calves¹

Age of Dam	Breed					
	Angus			Hereford		
	Creepfed	Non-Creepfed		Creepfed	Non-Creepfed	
		Adj.* ADG			Adj.* ADG	
2	1.61 (270)**	1.51 (667)	1.63 (252)	1.44 (541)	1.58 (30)	1.51 (33)
3	1.71 (351)	1.63 (855)	1.75 (280)	1.59 (778)	1.61 (31)	1.56 (42)
4	1.80 (287)	1.65 (952)	1.76 (361)	1.66 (775)	1.67 (32)	1.64 (25)
5	1.81 (276)	1.70 (790)	1.74 (267)	1.75 (733)	1.83 (9)	1.67 (25)
6	1.83 (284)	1.74 (720)	1.80 (192)	1.76 (717)	1.66 (4)	1.72 (19)
7	1.86 (255)	1.76 (534)	1.92 (129)	1.80 (549)	1.66 (5)	1.69 (16)
8	1.88 (158)	1.78 (424)	1.96 (104)	1.78 (454)	1.78 (5)	1.88 (7)
9	1.86 (125)	1.78 (320)	1.93 (85)	1.80 (325)	1.64 (7)	1.73 (13)
10	1.89 (92)	1.78 (216)	1.92 (33)	1.82 (204)	2.13 (1)	1.96 (2)
11	1.85 (81)	1.73 (156)	1.83 (24)	1.82 (99)	1.51 (1)	1.42 (1)
12	1.89 (44)	1.68 (121)	1.87 (18)	1.74 (67)	2.11 (1)	---- (0)
13	1.93 (37)	1.64 (90)	2.07 (8)	1.79 (18)	2.06 (2)	1.78 (1)
14	1.88 (19)	1.68 (58)	1.98 (8)	1.77 (20)	---- (0)	1.74 (1)
15	1.90 (13)	1.68 (42)	2.02 (6)	1.76 (10)	---- (0)	---- (0)
16	1.74 (8)	1.51 (19)	---- (0)	1.83 (5)	---- (0)	---- (0)
17	1.74 (2)	1.71 (6)	1.70 (1)	1.90 (1)	---- (0)	---- (0)
18	1.85 (2)	1.75 (5)	---- (0)	---- (0)	---- (0)	---- (0)

¹ Source: Marlowe (1962)

* Adjusted to a steer equivalent born between January 1 and May 31

** Number of observations

older cows had been proven to be capable of raising fast growing calves. These researchers found that old cows under good environmental conditions were equally as good as middle aged cows in producing calves.

Marlowe et al. (1965) reported age of cow to have a significant ($P < 0.01$) effect on calf gains in 111 Angus and 82 Hereford herds. Calf gains increased with age of cow from two to seven years, remained constant with age of cow from seven through 11-year-old cows and decreased slightly as age of cow increased slightly beyond 11 years. Minyard and Dinkel (1965), working with weaning weight data on 1,915 purebred Hereford and 436 purebred Angus calves from 20 private herds, reported age-of-dam adjustment factors as follows: 69, 33, 21, 13, 4, 3, 0, 9, 23, 24, 38 and 41 lb. for 2-, 3-, 4-, 5-, 6-, 7-, 8-, 9-, 10-, 11-, 12-, and 13+ year-old cows respectively.

Warren et al. (1965) reported that, in performance records of 28,493 Hereford, Angus, grade Hereford and Santa Gertrudis calves in the Georgia Beef Cattle Improvement Association program from 1958 through 1964, age of dam adjustment factors obtained for cows from two to 12 years old respectively were as follows: 1.17, 1.12, 1.07, 1.04, 1.03, 1.02, 1.00, 1.01, 1.01, 1.01 and 1.03. Mean weaning weights increased as age of dam increased through eight years. Eight-, 9-, 10- and 11-year-old cows produced calves of similar weights. Calves from cows 12 years old and older were comparable to calves from cows five and six years of age.

Cundiff et al. (1966), using data on 13,937 Hereford and Angus calves recorded in the Oklahoma Beef Cattle Improvement Association program from 1959 to 1962, reported 205-day weaning weights to have

increased 22 kg. as cows increased in age from two to four years. These researchers felt that this would suggest that classifying cows into three- to five-month increments between two and four years of age would result in more accurate corrections than those resulting from yearly increments. It was found that the effect of age of dam was essentially the same regardless of sex, breed, type of pasture, season of birth and type of management.

A summary of the effects of age of dam on weaning weight in beef calves is shown in Table 2.

In a study of data on 1,627 Hereford calves, a significant interaction between year and age of dam showed that in poor years there was a marked trend for the weaning weights of calves from young cows to be more adversely affected than weaning weights of calves from mature cows (Harwin et al. 1966). At weaning, calves from two-year-old cows averaged 21.3 kg. lighter than calves from mature cows during the five most favorable years, while during the five poorest years the difference was considerably greater at 39.9 kg. This is in close agreement with Vernon et al. (1964).

B. Sex of Calf Effects

The adjustment of weaning weights of beef calves to a common sex basis is essential when the calf production records of cows in a beef cattle breeding herd are compared. In general, bull calves are found to be slightly heavier at weaning than steer calves which are, in turn, slightly heavier than heifer calves (Tables 3 and 4). These weaning weights are commonly adjusted either on an additive (Table 3)

Table 2. Additive and multiplicative weaning weight adjustment factors for age of dam in beef calves

Author	Age of Dam (years)											
	2	3	4	5	6	7	8	9	10	11	12	
	Additive (lb.)											
Botkin and Whatley (1953)		35	15									
Koch and Clark (1955)		41	18	6	0	3	6	12	24			
Clum et al. (1956)	35	12	5	0	0	0	0	0	0	3	8	
Reynolds et al. (1958)	67	35	15									
Brown (1960) ¹	36	17	6	-8	0	-6	28	-17				
	14	2	-9	-6	0	-10	-33	-9				
	64	36	17	22	0	-9	0	18				
Holzman (1960)	70	35	20	0	0	0	0	10	20	25	40	
Brinks et al. (1962) ¹		30	17	5	0	-1	-3	-1	5	5	5	
Lawson and Peters (1964)	72	37	18	0	0	0	0	9				
Vernon et al. (1964)		37	15									
Burgess and Bowman(1965) ¹	34	14	0	0	0	0	-14	-14	-14			
Minyard and Dinkel (1965)	69	33	21	13	4	3	0	9	23	24	38	
	Multiplicative											
Marlowe and Gaines (1958)	1.20	1.10	1.06	1.03	1.00	1.00	1.00	1.00	1.00	1.05	1.05	
Meade et al. (1959) ¹	1.09	1.09	1.05	1.00	1.00	1.00	1.00	1.00	1.00	1.03	0.96	
Warren et al. (1965)	1.17	1.12	1.07	1.04	1.03	1.02	1.00	1.01	1.01	1.01	1.03	

¹ base used is the average weaning weight of all calves under study

Table 3. Additive weaning weight adjustment factors¹
for sex of calf in beef cattle

Author	Sex of Calf			
	Bull	Steer	Male	Heifer ²
Botkin and Whatley (1953)			24.6	
Koch and Clark (1955)			26.2	
Clum et al. (1956)			25.2	
Reynolds et al. (1958)		34		
Meade et al. (1959)			24.3 24.3	
Brown (1960)			57 33 22	
Pahnish et al. (1961)	44-99 72-99 53-77			
Meade et al. (1963)	31	20		
Lawson and Peters (1964)		19.4		
Vernon et al. (1964)	53 41			
³ Cooper et al. (1965)				
Minyard and Dinkel (1965)	34			
Warren et al. (1965)	46.7			
³ Bradley et al. (1966)				
Harwin et al. (1966)	33 11			

1 in pounds

2 adjustment based on heifer weaning weight

3 trend followed but no specific information given

Table 4. Multiplicative weaning weight adjustment factors
for sex of calf in beef cattle

Author	Sex of Calf				¹ Basis for Adjustment
	Bull	Steer	Male	Heifer	
Clum et al. (1956)			1.00	1.08	male
Marlowe and Gaines (1958)	0.96	1.00		1.08	steer
	0.95	1.00		1.08	steer
Meade et al. (1959)			1.00	1.06	male
Brinks et al. (1961)	0.94	0.95		1.00	heifer
Swiger et al. (1961)	0.91			1.00	heifer
Swiger et al. (1962)	0.95	0.94		1.00	heifer
Marlowe et al. (1965)	0.93	1.00		1.06	steer
Loganathan et al. (1965)			1.00	1.09	male
Warren et al. (1965)	0.94	1.00		1.04	steer

¹Basis is formed by setting one of the sexes equal to 1.00 and comparing the other sexes with this base.

or multiplicative (Table 4) basis to either a steer or heifer basis.

Several workers have indicated a rather definite trend for the difference in weaning weight between bull and heifer calves to be more pronounced as the level of environmental conditions (accessibility of a creepfeeding apparatus, favourable forage growing seasons, increased age of calf and increased age of dam) improved (Clum et al. 1956; Marlowe and Gaines, 1958; Brown, 1960; Vernon et al. 1964; Cooper et al. 1965; Marlowe et al. 1965; Pahnish et al. 1965; Harwin et al. 1966). This differential response appeared to be associated with the greater growth potential of bull calves, tending to make them more susceptible to preweaning limitations in nutritional environment and to readily increase the growth margin of bull calves over heifer calves when subjected to a high level of nutritional environment.

C. Month of Birth Effects

Month or season of birth is a major non-genetic factor that affects the weaning weight of beef calves at a standard age. Weaning weights are usually adjusted to a standard 205 day age by subtracting birth weight from weaning weight and dividing the difference by days of age, then multiplying by 205 and adding the birth weight.

Clum et al. (1956) reported March calves were heaviest, being 31 lb. above the 25-year average for adjusted weaning weights. September calves were 36 lb. lighter than the mean. The data in this study were adjusted for month of birth effects by adding -12, -18, -21, -17, -8, 0, +8, +12, +15, +11, +4 and -5 lb. to weights of calves born during the twelve months January to December respectively.

Season of birth was reported to be of statistical and practical importance for growth rate of non-creepfed calves but of little importance on creepfed calves (Marlowe and Gaines, 1958). Non-creepfed calves born during June through September grew about 0.1 lb. per day slower than those born February through May. Another group of researchers are in rather close agreement with this work; calves born in April, May and June were eight, 25 and 38 lb. lighter at 205-day weaning than the average of calves born in January, February and March (Reynolds et al. 1958). Calves born in the summer months were 60 lb. lighter at 205 days in this study.

Marlowe (1962) summarized over 21,000 records for month of birth in the Virginia Beef Cattle Improvement Association Performance Testing program (Table 5). Calves born after June 1 were at a decided disadvantage and calves born from August through October were considerably below the mean for the preweaning average daily gain trait. Calves born during September had the lowest gains of all among the Angus and Hereford breeds. There was a gradual increase in gains of calves born between September and March, a slight additional increase during March and April, a decrease in May, and a drastic decrease after the first of June.

Vernon et al. (1964) reported that calves born in December and January weighed less at birth than those born in February, March and April but weighed more at 180 days. This is in fairly close agreement with Burgess and Bowman (1965) who found that calves born in the fall and winter were slightly heavier at a standard age than those born in spring and summer. Marlowe et al. (1965) reported that calves born during February through May gained about 4% faster to weaning than

Table 5. Preweaning average daily gain of creepfed and non-creepfed calves by breed and month of birth

Month of Birth	Breed					
	Angus		Hereford		Shorthorn	
	Adj.* Average Daily Gain		Non-creepfed		Non-creepfed	
	Creepfed	Non-creepfed	Creepfed	Non-creepfed	Creepfed	Non-creepfed
January	1.83 (352) ¹	1.74 (1858)	1.82 (469)	1.70 (1574)	1.84 (17)	1.66 (20)
February	1.86 (379)	1.81 (1830)	1.86 (263)	1.80 (1217)	1.84 (22)	1.71 (49)
March	1.90 (490)	1.84 (1986)	1.97 (282)	1.83 (1234)	1.76 (25)	1.76 (44)
April	1.95 (234)	1.85 (1079)	1.91 (157)	1.85 (727)	1.69 (17)	1.77 (32)
May	1.90 (129)	1.81 (326)	1.94 (104)	1.79 (187)	1.90 (7)	1.98 (17)
June	1.82 (59)	1.57 (111)	1.83 (53)	1.51 (36)	1.86 (4)	---- (0)
July	1.81 (121)	1.59 (160)	1.82 (28)	1.38 (8)	1.87 (3)	1.42 (9)
August	1.75 (113)	1.49 (85)	1.94 (30)	1.23 (10)	1.44 (5)	1.61 (5)
September	1.72 (127)	1.44 (193)	1.91 (90)	1.19 (24)	1.53 (10)	1.58 (2)
October	1.67 (117)	1.50 (220)	1.80 (31)	1.46 (27)	1.82 (10)	1.67 (3)
November	1.73 (129)	1.57 (607)	1.51 (176)	1.52 (220)	1.78 (6)	1.37 (2)
December	1.78 (157)	1.64 (1232)	1.70 (138)	1.63 (929)	1.73 (2)	1.62 (4)

Source: Marlowe (1962)

* Adjusted for age of dam and sex of calf

¹ Number of observations in each age group

January and June calves, 12% faster than July through October calves and 6% faster than November and December calves. Warren et al. (1965) reported that September calves were lightest and February calves were heaviest. November, January, February and March calves were comparable in weight at weaning and were significantly heavier than October and December calves which were comparable to April calves.

D. Year of Birth Effects

Yearly changes in the nutritional environment in which the beef calf is raised can greatly affect its preweaning growth. Clum et al. (1956) reported year effects varied from -51 lb. for 1942 to +51 for 1949 over the 25-year period of his study. Year of birth effects ranging up to 145 lb. were reported by Meade et al. (1963). Lawson and Peters (1964) also found weaning weight to be affected by year of birth.

The interactions of year of birth and sex of calf reported by Harwin et al. (1966) have been previously discussed.

E. Age of Calf Effects

Marlowe and Gaines (1958) reported on a study where age of calf was divided into seven equal periods of 30 days in length (90 to 300 days). No significant differences were apparent in the growth rates of calves from 90 to 210 days of age; a slight decline was evidenced in the next period and a rather sharp decline occurred from 241 to 300 days. The decline in the older groups was thought to be due largely to three factors: (1) the cows were approaching the end of their lactation period, (2) the growth period extended farther into the period of poorer grazing conditions and (3) some of the older calves were

weaned prior to the time they were weighted. Marlowe (1962) reported that, under some circumstances, some adjustment for age differences would be desirable. When creepfeeding was practiced, Angus calves under 120 days of age were at a slight advantage and the older calves did almost as well as calves between 120 and 240 days. On the other hand, Hereford and Shorthorn calves under 120 and over 240 days were at a decided disadvantage. However, when calves were creepfed and all were weighed within the age limits of 120 to 240 days, there seemed no need to adjust gains because of differences in calves' ages particularly among the Angus calves.

F. Other Effects

The beneficial effects of creepfeeding on calf preweaning growth have been already discussed (Marlowe and Gaines, 1958; Brown, 1960; Marlowe, 1962; Marlowe et al. 1965; Cundiff et al. 1966).

Two groups of researchers reported different results with regard to previous lactation status. Fitzhugh et al. (1966) reported that cows that were not lactating in the previous year produced heavier calves. However, Meade et al. (1963) reported that previous lactation status had no significant effect on 205-day weaning weight.

III. Non-Genetic Factors Affecting Post-Weaning Performance in Beef Cattle

Several factors have been discussed that affect the preweaning gains of beef calves. Some of these factors, such as the sex of the calf and feeding and management practices, continue to be important during the post-weaning period. Other factors such as age of dam,

month of birth and year of birth become of somewhat lesser importance (Marlowe, 1962).

A. Age of Dam Effects

The necessity of adjusting calf weaning weights for age of dam is widely recognized. However, there is some hesitancy with regard to the need for adjusting yearling weights for age of dam.

Koch and Clark (1955) suggested fall yearling weight adjustments for age of dam were 24, 13, 3, 0, 2, 4, 7 and 14 lb. for 3- to 10-year-old cows respectively. Another group of workers reported age of dam adjustment factors of +34, +9, +5, 0, -4, -2, +3 and +1 kg. for final (386 day) weight for cows aged three to 10+ years of age respectively (Brinks et al. 1962). Schalles and Marlowe (1967) reported that age of dam had a significant positive effect on the 365-day weight of bulls. Waugh and Marlowe (1969) found that yearling cattle out of young dams had the slowest lifetime growth rate whereas those out of mature dams (six- to 11-year-olds) had the fastest growth rate. The average weight differential of Angus bulls and heifers out of two-year-old dams versus mature Angus dams was 15.9 kg. for heifers and 20.4 kg. for bulls. It appears that post-weaning growth does not always compensate for a poor preweaning environment.

B. Other Effects

According to Marlowe (1962), age of calf at beginning of test, pre-test treatment of calf, length of test period and feed and management during the test period have important influences on post-weaning gains. Schalles and Marlowe (1967) found that bulls that were

younger going on test had a heavier 365-day weight. Short yearlings (10 to 13 months of age) were found to have the highest growth rate in another study (Waugh and Marlowe, 1969) with growth rate decreasing in each successive age group.

In contrast to its effect on growth rate of calves up to weaning (Marlowe et al. 1965) month of birth appeared to have no significant influence on the growth rate of yearling cattle (Waugh and Marlowe, 1969). In this same study, creepfeeding was found to have significantly increased the lifetime average daily gain of Hereford cattle but had no significant effect on Angus cattle. This could be explained by the larger milk supply provided by the Angus cows. Hereford yearlings that were creepfed as calves had a 0.057 kg. advantage in lifetime average daily gain among the bulls and 0.034 kg. advantage among the heifers over the non-creepfed cattle.

IV. Genetic Basis for Selection in Beef Cattle

Heritability can be defined as the percentage ratio of the additive genetic variance to the total phenotypic variance (Falconer, 1960). A knowledge of heritability might permit prediction of the rate of progress to be expected in the selection of a given trait. Genetic correlations between traits enables the prediction of correlated response in one trait when selection pressure is applied to another trait. Thus an understanding of these concepts would be very helpful in any selection program designed for the improvement of production traits in beef cattle.

Warwick (1958) summarized heritability estimates for various beef cattle traits (Table 6).

Table 6. Heritability estimates for beef cattle characters

Character	No. of Estimates	Ave. of Estimates	Range of Estimates
Birth Weight	15	41	11-100
Weaning Weight	26	30	-13-100
Post Weaning Feedlot Gain	13	45	19-70
Post Weaning Pasture Gain	6	30	9-43
Conformation Grade at Weaning	16	26	0-53
Conformation Grade at Slaughter	5	39	-13-63

Source: Warwick (1958)

The heritabilities and correlations between average daily gain to weaning, conformation score and average daily gain on feed test have been extensively studied. Brinks et al. (1962) estimated the heritability of feedlot gain and final weight to be 0.40 and 0.48, respectively. They found no serious negative relationship between average daily gain to weaning and average daily gain on feed test. The heritability of feedlot gain found in this study is similar to that found by Warwick (1958).

Comparable results were obtained by Swiger et al. (1963) who reported heritability estimates of 0.28, 0.45, and 0.47 for weaning weight, 398-day weight and 550-day type score, respectively. They reported small but positive genetic correlations between the weight-for-age traits and type score.

Shelby et al. (1963) reported the heritabilities of final weight and feedlot average daily gain to be 0.64 and 0.48 respectively in 10 years of Miles City steer data. The heritability of feedlot average daily gain was similar to that reported by Warwick (1958).

Brown and Gacula (1964) reported the heritability of type score to be 0.15 ± 0.15 , the heritability of initial test weight to be 0.27 ± 0.13 , and average daily gain on test to have a heritability of 0.93 ± 0.18 . The heritability of type score was somewhat lower than might be expected (Warwick, 1958). The heritability of average daily gain on test was very high in this study when compared to the results of other researchers (Warwick, 1958; Brinks et al., 1962).

Heritability of preweaning average daily gain was reported to be

0.25 for purebred Brahms but dropped to 0.17 in the Braham X Shorthorn crossbred herd due to the estimated negative covariance of additive genotype for growth and maternal effect (Deese and Koger, 1967). These estimates are in agreement with results obtained by Warwick (1958).

Swiger et al. (1965) reported that the heritability of weaning weight was 0.58, post-weaning gain was 0.60 and final weight was 0.72. In general, these results are somewhat higher than the average of those reported by Warwick (1958). They also found the phenotypic correlation between weaning weight and post-weaning average daily gain to be 0.61, between weaning weight and final weight to be 0.86 and between post-weaning average daily gain and final weight to be 0.93.

Marlowe and Vogt (1965) studied preweaning average daily gain and weaning grade in 12,145 Angus calves and 8,279 Hereford calves. They reported heritability estimates of 0.38 ± 0.03 and 0.31 ± 0.04 for preweaning average daily gain in the Angus and Hereford calves respectively. Heritability estimates of 0.36 ± 0.04 and 0.33 ± 0.04 for weaning grade were calculated for the two breeds respectively. Heritability estimates for calf weaning weight were reported to be 0.32 ± 0.16 and 0.33 ± 0.08 respectively in Angus and Hereford calves (Minyard et al. 1965). Warwick (1958) reported results which are in close agreement to those obtained in this study.

Research on type indicates that the traditional beef type animal preferred by most feeders and packers is of little value from the growth and cutability point of view. Knox (1957) found that breeding for short legs and short bodies was found to limit the size of cattle, and the only advantage of this type of animal was its ability to fatten

at lighter weights.

V. Results of Selection in Beef Cattle

There are several instances reported in the literature of improvement in weight traits due to selection pressure being applied over time in beef cattle. Chapman et al. (1969) reported seven years of results in four herds of Polled Hereford cattle in which sires used were selected for one of the following: high daily rate of post-weaning gain, high weaning weight, high yearling type, or a combination of average levels of performance in the three first-mentioned traits. On the average, only selection for high daily rate of post-weaning gain and high weaning weight produced beneficial results in the form of increased weights.

Using high yearling weight as the sole criterion for selection, the Canada Department of Agriculture Experimental Station at Lacombe reported sex-averaged yearling weight in a closed herd of Shorthorn cattle to have increased by 6.6 lb. per year as compared to the control herd during the 9-year period from 1960 - 1968 (Newman, 1969). Rahnefeld (1968) at the Canada Department of Agriculture Experimental Station at Brandon, reported sex-averaged yearling weights in Shorthorn cattle to have increased by 7.5 lb. per year as compared to the control herd during the 8-year period from 1960 to 1967. The selection programs at both stations involved complete replacement of bulls and approximately one-quarter of the females each year.

Nelms et al. (1967) reported that, in a closed line of 302 Hereford calves born over a 12-year period, increases in birth weight, 180-day weight, gain per day on feed test and final weight were 0.70 lb., 1.78 lb.,

0.25 lb. and 6.45 lb. per year. In this study, unadjusted final weight was the only criterion for selection.

Bradley et al. (1966) reported that the progeny of the high-gaining sire in their study gained significantly ($P < 0.05$) faster during the pre- and post-weaning periods and exhibited significantly ($P < 0.05$) heavier weaning and final weights than of the low-gaining sire. These sire differences indicate that selection for post-weaning gain significantly increased preweaning gain, weaning weight and final weight evidencing strong correlated responses between post-weaning gain and the other pre- and post-weaning traits. Such is expected on the basis of the moderately high heritability estimate (Warwick, 1958).

Flower et al. (1964) reported an estimate of the mean average genetic gain for birth weight and weaning weight in seven lines of Hereford cattle to be 0.96 lb. and 4.56 lb. per year respectively during an eight year selection program.

VI. Commercial Application of Beef Cattle Performance Testing Programs

Wentworth (1933) stated that, in the early 1930's, phenotypic selection still governed beef cattle breeding and that it was too far removed from market requirements. The industry was faced with the problem of making the grading of dressed carcasses compare with the grading of animals on foot. It was suggested at this time that selection be geared toward direct measurement and that accurate standards of values be found.

The first research into the feasibility of beef cattle performance programs was initiated by the U.S.D.A. at the U.S. Range Livestock

Research Station in Montana during the period 1930 to 1935 (Baker, 1967). The period 1945 to 1950 brought the beginning of the first extension beef programs in California, New Mexico and Montana. The early 1950's found the inauguration of beef cattle performance testing programs in several states. The use of computers for the processing of field data began at this time. The next several years showed pronounced growth in beef cattle improvement programs, beef cattle improvement associations and bull and steer testing stations.

Maddox (1967) reported that the breed improvement program the American Angus Association established in 1959 had 523 breeder participants as of February 16, 1966. During 1965, 31,903 weaning weights and 11,027 yearling weights were recorded. The American Hereford Association established their improvement program in September, 1964. As of March 1, 1966, 25,300 cows were enrolled in the program.

Mast (1967) reported that the Extension Service of the U.S.D.A. was involved in beef cattle ROP programs covering 7,480 herds and 518,531 cows in 1967.

The Canada Department of Agriculture has been involved in the performance testing of beef cattle since 1956. After twelve years, the testing of beef cattle has become quite popular in Canada (Table 7.)

The province of Ontario does not participate in the Federal-Provincial beef cattle performance testing program but has its own program under the supervision of the Ontario Department of Agriculture and Food.

Alberta has had greatly increased breeder participation in the Federal-Provincial Record of Performance program for beef cattle since

Table 7. Herds and calves on test in Canada by province in 1967

Province	No. Herds	No. Calves Weighed
British Columbia	34	830
Alberta	175	5,310
Saskatchewan	146	3,558
Manitoba	45	1,244
Quebec	3	91
New Brunswick	13	78
Nova Scotia	8	40
	424	11,151

Source: Twelfth Annual Report on Record of Performance for Beef Cattle in Canada - 1967-1968. Canada Department of Agriculture, Ottawa.

its inauguration in 1959 (Table 8).

Rutherford et al. (1966) reported results of 227 survey replies from 1235 southern Indiana commercial beef cow herd operators. These replies were divided into three groups based on herd size. The survey requested that the producers stipulate which three factors from a list of eleven that they consider to be most important when buying a herd bull. These eleven factors were: (1) size, (2) show winnings, (3) health, (4) age, (5) price, (6) conformation, (7) weight, (8) reputation of the breeder, (9) breed type, (10) line of breeding and (11) other. Operators in all three groups picked conformation and size as the first and second most important factors respectively. In the small size cow herds, health and breed type were equally important as the third factor. Reputation of breeder was the third most important factor for medium and large size cow herd operators. Show winnings was considered least important in bull selection by all three groups. A second aspect of the survey involved the price each herd operator paid for bulls. Small herd operators paid an average of \$313.58, medium herd operators paid an average of \$380.86 and large herd operators paid an average of \$483.22 for their bulls.

Marlowe (1969) reported that, at the BCIA bull testing station sales at Culpeper, Virginia from 1959 to 1968, the most important criterion in the selection of 791 Hereford and Angus bulls by bull buyers was type and conformation as evaluated by a numerical grade. The grade range was from 12 to 16. The average increase per grade point was \$110.00 among the Angus bulls and \$170.00 among the Hereford bulls. The importance of 365-day weight and lifetime ADG as criteria in bull selection was quite different for the two breeds. Angus bull buyers placed great emphasis

Table 8. Herds and calves on test by year in Alberta

Year	On Weaning Test		On Feed Test	
	No. Herds	No. Calves Weighed	No. Herds	No. Calves Weighed
59-60	54	1,169	53	1,059
60-61	63	1,795	63	1,506
61-62	60	2,095	60	1,699
62-63	76	2,703	74	2,264
63-64	91	3,105	87	2,479
64-65	97	3,673	99	3,319
65-66	122	4,599	119	3,723
66-67	147	5,724	142	4,825
67-68	174	6,659	177	5,690
68-69	220	7,760	215	6,399
69-70	397	14,625	378	11,605
		53,907		44,508

Source: Lore (1970)

(second only to grade) on lifetime ADG. Hereford bull buyers placed their emphasis on 365-day weight instead of lifetime ADG. When an index value was substituted for final grade and lifetime ADG, each index point above the average was worth approximately \$25.00 for either Hereford or Angus bulls.

EXPERIMENTAL

I. Objectives

This project was undertaken to:

- (1) determine what changes, if any, have been made in preweaning average daily gain (preweaning ADG), post-weaning average daily gain (post-weaning ADG), weight-per-day of age at end of test (WDA), and end-of-test conformation score (CS) in beef cattle herds enrolled in the Federal-Provincial Purebred Beef Cattle Performance Testing Program in Alberta since its inauguration in 1959,
- (2) evaluate progress in terms of the expected and propose modifications, if necessary, and
- (3) determine the relationships among the four traits studied.

II. Materials and Methods

A. The Record of Performance Program

The main source of data was from the Alberta section of the Federal-Provincial Record of Performance (ROP) Program. The main features of this program in Alberta according to Lore and Davies (1969) are:

- (1) The program is designed to assist breeders to identify and select, on a within-herd basis, breeding stock of high calibre for both body conformation and performance.
- (2) The program is a home test to cover the entire herd.
- (3) The calves are weighed at weaning, as close to 190 days as possible.
- (4) Calves are accepted in groups of not less than five and not more than 90 days range in age within a group.

(5) The feeding period is 168 days in length and does not allow for an adjustment period after weaning. The feeding of or implanting of hormones is prohibited.

(6) The use of a foster mother or nurse cow is prohibited.

(7) The report to the breeder, upon the completion of the feeding test, is to contain the following information:

- (a) average daily gain, birth to weaning,
- (b) index of average daily gain, birth to weaning,
- (c) average daily gain during the feed test period,
- (d) index of average daily gain during the feed test period,
- (e) average daily gain, birth to end of test,
- (f) lifetime gain index.

The correction factors used for adjusting of calf weaning weight for age of dam for two-, three-, four- and five-year old cows are 1.13, 1.09, 1.06 and 1.03, respectively.

The conformation score is based on a visual appraisal of all animals placing them into one of five categories as follows:

- (1) Choice
- (2) Very Good
- (3) Good
- (4) Commercial
- (5) Reject

There were no precise standards by which an animal was conformation scored.

Data was also available on two lines of beef cattle from the

University of Alberta Beef Cattle Breeding Project at Kinsella. The University of Alberta established what might be called a breed development project in 1960. The plan was to compare progress from selection for high yearling weight in a straightbred herd (Hereford) with that from within a hybrid foundation (Charolais, Angus and Galloway combination).

In addition, thirteen years of continuous data was available from each of two commercial ranches in Alberta. These ranches, designated in this study as Commercial Ranch A and Commercial Ranch B, used high growth rate as the main criterion for selection.

B. The ROP Data

(i) Source

The Data Processing Centre of the Production and Marketing Division of the Canada Department of Agriculture forwarded duplicates of all data cards for the calves born during the years 1962 to 1967 inclusive. Performance results for calves born during 1968 and 1969 were obtained mainly from field records. Data card records for the calves born during the years 1959 to 1961 inclusive were either missing or in poor condition, and, as a result, were not available, as such, for this analysis. It was necessary to revert to the original field records and to repunch the missing data to make a complete analysis.

(ii) Adjustment

Data was recorded on computer punch cards using one card to cover each of the three phases of the performance test. The first card was the "weaning card" on which all information for each animal pertinent

to the period prior to weaning was recorded (Appendix A, Table 1). The second card was the "feed card" (Appendix A, Table 2) on which pertinent feed test period information was punched. The third of the three punch cards for each animal was the "final test card" which summarized, to an extent, the data pertinent to the entire test period (Appendix A, Table 3). Data from the cards were transferred to 9-track IBM Magnetic Tape and at the same time the three-card system was combined into a single record for each animal (Appendix A, Table 4).

Actual average daily gain to weaning was used instead of adjusted average daily gain to weaning because of variations in the adjustment used from year to year in correcting preweaning average daily gain for age of dam and because of the difficulty in obtaining this information from the field data.

(iii) Description

Two criteria were considered when deciding which of the herds on the ROP program would be included in the evaluation; namely, the number of years of performance testing within a herd and the number of animals on test. No herds were selected for evaluation unless (1) the owner had joined the program in its initial year of operation or (2) there was evidence of a relatively large herd size and continuous performance testing each year. Forty-three herds, of which 29 were Hereford and 14 were Angus were thus chosen for analyses. Weaning weights from 18,176 calves were available (Table 9).

Table 9. Number of cattle on performance test evaluation
by breed, trait and sex

Breed	Sex	No. Calves Weaned	No. Type-Scored	No. On Feed Test	No. On WDA Test
Hereford	M*	5,667	3,123	4,788	4,788
	F**	5,853	3,545	5,355	5,355
	Total -	11,520	6,668	10,143	10,143
Angus	M	3,485	1,721	2,625	2,625
	F	3,171	1,646	2,489	2,489
	Total -	6,656	3,367	5,114	5,114
Grand Total -		18,176	10,035	15,257	15,257

* Males (Bulls)

** Females

C. The Analyses

An IBM 360-67 computer was used to calculate regressions and mean squares. The computations followed procedures outlined by Steel and Torrie (1960). Means were calculated for each of the four traits on a within-herd, within-sex, within-year basis (Appendix B, Pages 1 to 23). Weighted regression analyses were calculated using these averages. The major Fortran program for the analyses consisted of 278 statements (Appendix B, Pages 24 to 30).

III. Results

It must be emphasized that extreme differences in the environmental factors that each of the 43 herds was tested under meant that a highly accurate analysis of the effect of the ROP program on beef cattle improvement was almost impossible. Among the varying environmental factors were year effects, age-of-dam effects (actual preweaning average daily gain was used), creep feeding effects, and extreme differences in the levels of general management between and within herds.

Regressions of each trait for each herd over the years of record were used to estimate change in each trait per year. These are given in Tables 10 and 11. Results for each trait will be presented in relation to the number of herds having significant ($P < 0.05$) positive or negative regressions as well as the number of herds in which no significant change in the trait could be detected. It was necessary to multiply all results associated with conformation by minus one because a decline in conformation score would indicate an improvement in the conformation of the animal and not a decline for this trait.

The relative effects of crossbreeding and selection in beef cattle improvement at Commercial Ranches A and B were not determined. This approach to beef cattle improvement was evaluated only on its overall merit in increasing the rate of growth of cattle.

Table 10. Regression coefficients with standard errors of the four traits on years in males

Herd	Preweaning ADG	Conformation Score	Post-Weaning ADG	Weight-Per-Day Of Age
1 H-AAIN	-0.203*± 0.045	-0.054 ± 0.040	0.141 ± 0.060	-0.100*± 0.022
H-AET	0.006 ± 0.012	0.181*± 0.037	0.010 ± 0.012	0.019 ± 0.018
H-ARJ	-0.001 ± 0.013	0.052 ± 0.028	-0.092*± 0.021	-0.043*± 0.016
H-ASL	-0.133*± 0.029	-0.097 ± 0.099	0.003 ± 0.143	-0.099 ± 0.074
H-BBF	-0.032*± 0.014	0.143*± 0.036	-0.007 ± 0.019	-0.033*± 0.013
H-BGN	-0.044*± 0.015	0.052 ± 0.059	-0.057*± 0.018	-0.084*± 0.018
H-BKP	0.015 ± 0.018	0.046 ± 0.028	0.046*± 0.020	0.026 ± 0.019
H-BSB	-0.070 ± 0.028	0.080 ± 0.110	0.037 ± 0.060	0.001 ± 0.049
H-BVZ	0.007 ± 0.028	0.138 ± 0.110	0.021 ± 0.039	0.030 ± 0.035
H-BZD	-0.021 ± 0.019	0.177*± 0.055	-0.045 ± 0.040	-0.063*± 0.017
H-DEE	0.021 ± 0.012	-0.000 ± 0.034	0.000 ± 0.023	0.010 ± 0.021
H-DSF	-0.001 ± 0.014	-0.014 ± 0.020	0.005 ± 0.021	-0.002 ± 0.019
H-ETU	-0.031 ± 0.027	-0.029 ± 0.032	0.046 ± 0.048	-0.007 ± 0.028
H-EZC	-0.010 ± 0.022	-0.064 ± 0.033	0.051 ± 0.033	0.046 ± 0.032
H-FSI	-0.024 ± 0.019	-0.090 ± 0.072	-0.041 ± 0.027	-0.017 ± 0.033
H-GDT	-0.027 ± 0.020	0.014 ± 0.039	0.039*± 0.017	-0.027 ± 0.023
H-GUR	-0.002 ± 0.017	0.010 ± 0.051	0.178 ± 0.100	0.117*± 0.038
H-HDA	-0.019*± 0.006	0.035 ± 0.020	-0.002 ± 0.008	-0.013 ± 0.013
H-IAY	-0.049*± 0.015	0.104*± 0.018	0.098*± 0.029	0.002 ± 0.016
H-IBO	0.008 ± 0.008	0.116*± 0.034	-0.016 ± 0.016	-0.010 ± 0.016
H-JNT	-0.003 ± 0.018	0.000 ± 0.027	-0.081*± 0.017	-0.048*± 0.019
H-MCI	-0.007 ± 0.010	0.032 ± 0.021	0.021 ± 0.016	-0.000 ± 0.015
H-MFM	-0.009 ± 0.011	0.021 ± 0.053	0.031 ± 0.021	0.007 ± 0.016
H-OHB	-0.029 ± 0.025	0.110*± 0.042	0.054 ± 0.072	-0.024 ± 0.054
H-OTH	-0.037 ± 0.029	0.081 ± 0.065	-0.076 ± 0.056	-0.042 ± 0.046
H-RIO	0.035*± 0.014	0.204*± 0.045	-0.015 ± 0.017	0.011 ± 0.019
H-SBF	0.030*± 0.010	0.146*± 0.045	-0.032 ± 0.019	-0.009 ± 0.012
H-UP	-0.059*± 0.024	0.126 ± 0.078	-0.015 ± 0.028	-0.026 ± 0.020
H-XUB	-0.013 ± 0.021	0.010 ± 0.036	-0.005 ± 0.023	-0.015 ± 0.026
2A-AYE	-0.019 ± 0.015	-0.035 ± 0.061	0.011 ± 0.020	0.005 ± 0.023
A-BBP	-0.003 ± 0.011	0.094*± 0.022	-0.010 ± 0.018	-0.019 ± 0.015
A-BC	-0.042 ± 0.019	0.004 ± 0.059	0.007 ± 0.027	-0.047 ± 0.022
A-CCE	0.010 ± 0.014	0.049 ± 0.030	0.005 ± 0.016	-0.014 ± 0.013
A-CMA	0.013 ± 0.009	-0.015 ± 0.016	0.002 ± 0.020	0.005 ± 0.006
A-DHR	0.044*± 0.005	-0.094 ± 0.067	-0.021 ± 0.024	0.037 ± 0.018
A-DHV	-0.011 ± 0.013	0.010 ± 0.059	0.032 ± 0.016	0.005 ± 0.015
A-FHR	0.014 ± 0.048	-0.032 ± 0.077	0.066*± 0.025	0.027 ± 0.033
A-GBG	0.009 ± 0.009	0.020 ± 0.127	0.060*± 0.016	0.073*± 0.015
A-JST	0.009 ± 0.016	0.120 ± 0.043	0.046 ± 0.037	0.038 ± 0.017
A-MN	0.011 ± 0.015	-0.016 ± 0.014	0.048*± 0.019	0.018 ± 0.021
A-OAF	0.008 ± 0.016	0.179*± 0.024	0.032 ± 0.027	0.016 ± 0.022
A-TLT	0.030 ± 0.014	0.046 ± 0.041	0.011 ± 0.010	0.011 ± 0.011
A-VN	0.020 ± 0.022	0.132*± 0.026	0.054 ± 0.027	0.055*± 0.013

* Regression significantly different from zero at ($P < 0.05$)

1 Hereford

2 Angus

Table 11. Regression coefficients with standard errors of the four traits on years in females

Herd	Preweaning ADG	Conformation Score	Post-Weaning ADG	Weight-Per-Day Of Age
¹ H-AAIN	-0.117*± 0.023	-0.097 ± 0.053	-0.023 ± 0.084	-0.107 ± 0.033
H-AET	-0.004 ± 0.012	0.173*± 0.052	0.038*± 0.012	0.015 ± 0.009
H-ARJ	0.002 ± 0.018	0.020 ± 0.027	0.004 ± 0.038	-0.003 ± 0.015
H-ASL	-0.066 ± 0.021	-0.163 ± 0.070	-0.076 ± 0.080	-0.136 ± 0.056
H-BBF	-0.023 ± 0.012	0.113*± 0.040	-0.000 ± 0.015	-0.013 ± 0.011
H-BGN	-0.059*± 0.011	0.001 ± 0.022	-0.020 ± 0.021	-0.074*± 0.014
H-BKP	0.018 ± 0.009	0.053 ± 0.047	0.068*± 0.017	0.034 ± 0.017
H-BSB	-0.050 ± 0.022	-0.026 ± 0.061	0.012 ± 0.039	-0.048*± 0.018
H-BVZ	0.006 ± 0.015	0.000 ± 0.090	0.012 ± 0.027	0.025 ± 0.029
H-BZD	-0.025 ± 0.019	0.126 ± 0.070	-0.012 ± 0.029	-0.055*± 0.012
H-DEE	0.016 ± 0.012	-0.006 ± 0.018	-0.027 ± 0.019	-0.010 ± 0.019
H-DSF	-0.016 ± 0.014	0.061*± 0.015	0.065*± 0.020	0.020 ± 0.018
H-ETU	-0.050 ± 0.031	-0.007 ± 0.027	-0.007 ± 0.047	-0.037 ± 0.023
H-EZC	-0.017 ± 0.011	0.033 ± 0.091	-0.010 ± 0.014	0.021 ± 0.017
H-FSI	0.000 ± 0.013	-0.050 ± 0.045	0.039 ± 0.019	0.034 ± 0.024
H-GDT	-0.011 ± 0.013	0.069 ± 0.039	0.028 ± 0.017	0.003 ± 0.016
H-GUR	-0.013 ± 0.011	-0.064 ± 0.142	0.171 ± 0.071	0.104*± 0.031
H-HDA	-0.005 ± 0.007	0.001 ± 0.099	0.025 ± 0.015	0.007 ± 0.008
H-IAY	-0.037 ± 0.016	0.015 ± 0.020	0.065*± 0.019	0.001 ± 0.015
H-IBO	0.005 ± 0.007	0.119 ± 0.054	0.003 ± 0.016	0.011 ± 0.017
H-JNT	0.010 ± 0.018	0.091*± 0.013	-0.002 ± 0.019	0.005 ± 0.018
H-MCI	-0.009 ± 0.009	0.075*± 0.022	0.053*± 0.012	0.014 ± 0.014
H-MFM	-0.015 ± 0.013	0.153 ± 0.101	0.038 ± 0.045	0.021 ± 0.023
H-OHB	-0.025 ± 0.021	0.035 ± 0.035	0.080 ± 0.050	-0.009 ± 0.031
H-OTH	-0.039 ± 0.031	0.001 ± 0.063	0.001 ± 0.029	-0.001 ± 0.029
H-RIO	0.028 ± 0.012	0.206 ± 0.090	-0.019 ± 0.035	-0.002 ± 0.024
H-SBF	0.022*± 0.007	0.064 ± 0.046	-0.041 ± 0.024	-0.022 ± 0.015
H-UP	-0.053*± 0.015	-0.001 ± 0.090	0.049 ± 0.042	0.014 ± 0.027
H-XUB	-0.031 ± 0.020	-0.017 ± 0.035	0.021 ± 0.020	-0.013 ± 0.019
² A-AYE	-0.008 ± 0.013	-0.098 ± 0.054	0.050*± 0.011	0.022 ± 0.018
A-BBP	-0.067*± 0.019	0.053 ± 0.033	-0.080 ± 0.046	-0.087*± 0.034
A-BC	-0.001 ± 0.012	-0.072 ± 0.055	0.013 ± 0.021	-0.019 ± 0.015
A-CCE	0.056*± 0.011	0.172 ± 0.062	0.035 ± 0.019	0.031*± 0.011
A-CMA	0.012 ± 0.008	0.003 ± 0.030	0.001 ± 0.019	0.006 ± 0.006
A-DHR	0.039*± 0.014	-0.001 ± 0.054	-0.025 ± 0.028	0.025 ± 0.017
A-DHV	0.013 ± 0.011	0.003 ± 0.049	0.028 ± 0.024	0.017 ± 0.022
A-FHR	-0.012 ± 0.039	-0.030 ± 0.033	0.036 ± 0.022	-0.011 ± 0.024
A-GBG	0.001 ± 0.009	0.208 ± 0.133	0.046 ± 0.025	0.081*± 0.021
A-JST	0.004 ± 0.020	-0.049 ± 0.103	0.021 ± 0.049	0.021 ± 0.041
A-MN	0.014 ± 0.017	-0.056 ± 0.085	0.077*± 0.027	0.049*± 0.021
A-OAF	-0.020 ± 0.014	0.158*± 0.032	0.016 ± 0.011	0.000 ± 0.019
A-TLT	0.020 ± 0.010	0.038 ± 0.030	-0.003 ± 0.018	0.011 ± 0.012
A-VN	-0.015 ± 0.016	-0.153 ± 0.243	0.123*± 0.021	0.054*± 0.017

* Regression significantly different from zero at ($P < 0.05$)

1 Hereford

2 Angus

A. Estimation of Change in Preweaning Average Daily Gain Over Years

A summary of the regressions involving preweaning ADG in the 43 herds under study is shown in Table 12. A total of 11,520 Hereford calves and 6,656 Angus calves were involved.

Table 12. Number of herds with positive and negative regressions of preweaning average daily gain over years

Value of Regression Coefficient	Number of Hereford Herds		Number of Angus Herds	
	M	F	M	F
Positive b Value *	2	1	1	1
Positive b Value NS	5	8	9	8
Subtotal	7	9	10	9
Negative b Value *	7	5	0	1
Negative b Value NS	15	15	4	4
Subtotal	22	20	4	5
Total	29	29	14	14

* Regression significantly different from zero at ($P < 0.05$)

NS Regression not significantly different from zero at ($P < 0.05$)

For males, improvement in preweaning ADG occurred in seven (24%) of the Hereford herds and 10 (71%) of the Angus herds. Significant ($P < 0.05$) increases were recorded for two (7%) of the Hereford herds and for one (7%) of the Angus herds. Male preweaning ADG decreased in 22 (76%) of the Hereford herds and four (29%) of the Angus herds;

significant ($P < 0.05$) decreases were found in seven (24%) of the Hereford herds. There was no significant ($P < 0.05$) decrease in male preweaning ADG over years in Angus herds.

Improvement in female preweaning ADG occurred in nine (30%) of the Hereford herds and nine (63%) of the Angus herds. There was significant ($P < 0.05$) improvement in this trait in one (3%) of the Hereford herds and one (7%) of the Angus herds. Female preweaning ADG decreased in 20 (70%) of the Hereford herds and five (35%) of the Angus herds. This decrease was significant in five (17%) of the Hereford herds and one (7%) of the Angus herds.

An average regression coefficient was obtained by averaging the 43 regression coefficients for preweaning ADG in both sexes. In males, the average regression coefficient was -0.014 ± 0.018 and in females it was -0.012 ± 0.015 lb. per day at weaning per year of test.

B. Estimation of Change in End-of-Test Conformation Score Over Years

A summary of the regressions of end-of-test conformation score over years in the 43 herds under study is shown in Table 13. There were 6,668 Hereford and 3,367 Angus cattle involved in this aspect of the evaluation.

Improvement in conformation score in males occurred in 22 (76%) of the Hereford herds and in eight (57%) of the Angus herds. This improvement was significant ($P < 0.05$) in eight (27%) of the Hereford herds and three (21%) of the Angus herds. Male conformation score decreased in seven (24%) of the Hereford herds and six (43%) of the Angus herds. There was no significant ($P < 0.05$) decrease in the

conformation trait over years in males in herds of either breed.

For females, improvement in conformation score was found in 20 (70%) of the Hereford herds and seven (50%) of the Angus herds. Significant ($P < 0.05$) increases were recorded for six (20%) of the Hereford herds and two (14%) of the Angus herds. Female conformation score decreased in nine (30%) of the Hereford herds and seven (50%) of the Angus herds. As in the males, there were no herds in which the decrease in conformation score was significant ($P < 0.05$).

Table 13. Number of herds with positive and negative regressions of conformation score over years

Value of Regression Coefficient	Number of Hereford Herds		Number of Angus Herds	
	M	F	M	F
Positive b Value *	8	6	3	2
Positive b Value NS	14	14	5	5
Subtotal	22	20	8	7
Negative b Value *	0	0	0	0
Negative b Value NS	7	9	6	7
Subtotal	7	9	6	7
Total	29	29	14	14

* Regression significantly different from zero at ($P < 0.05$)

NS Regression not significantly different from zero at ($P < 0.05$)

The average across-herd regression coefficient for conformation score was found to be 0.043 ± 0.047 grades per year in males and $0.026 \pm$ grades per year in females.

C. Estimation of Change in Post-Weaning Average Daily Gain Over Years

The regressions of post-weaning ADG per year on test are summarized in Table 14. Results for this trait were available on 10,143 Hereford cattle and 5,114 Angus cattle in the 43 herds under study.

Table 14. Number of herds with positive and negative regressions of post-weaning average daily gain over years

Value of Regression Coefficient	Number of Hereford Herds		Number of Angus Herds	
	M	F	M	F
Positive b Value *	3	5	3	3
Positive b Value NS	13	13	9	8
Subtotal	16	18	12	11
Negative b Value *	3	0	0	0
Negative b Value NS	10	11	2	3
Subtotal	13	11	2	3
Total	29	29	14	14

* Regression significantly different from zero at ($P < 0.05$)

NS Regression not significantly different from zero at ($P < 0.05$)

For males, improvement in post-weaning ADG occurred in 15 (55%) of the Hereford herds and 12 (86%) of the Angus herds. Significant ($P < 0.05$) increases were recorded for three (10%) of the Hereford herds and for three (21%) of the Angus herds. Male post-weaning ADG decreased in 13 (45%) of the Hereford herds and two (14%) of the Angus herds. This decrease was significant ($P < 0.05$) in three (10%) of the Hereford herds.

None of the Angus herds showed a significant ($P < 0.05$) decrease in male post-weaning ADG.

Improvement in female post-weaning ADG occurred in 18 (62%) of the Hereford herds and 11 (77%) of the Angus herds; significant ($P < 0.05$) increases were recorded in five (17%) of the Hereford herds while three (21%) of the Angus herds showed significant ($P < 0.05$) increases in post-weaning ADG in females. Female post-weaning ADG decreased in 11 (38%) of the Hereford herds and three (21%) of the Angus herds. There were no herds of either breed which showed a significant ($P < 0.05$) decrease in ADG after weaning in females.

The average across-herd regression coefficient for post-weaning ADG was found to be 0.015 ± 0.030 and 0.020 ± 0.029 lb. per day per year in males and in females respectively.

D. Estimation of Change in Weight-Per-Day of Age Over Years

A summary of the regression of weight-per-day of age on year of test taken at the end of the post-weaning gain test is shown in Table 15. Results were available on 10,143 Hereford and 5,114 Angus cattle.

Improvement in the WDA trait in males occurred in 10 (34%) of the Hereford herds and 11 (79%) of the Angus herds. Significant ($P < 0.05$) increases occurred in one (3%) herd of males of the Hereford breed. In two (14%) of the Angus herds significant ($P < 0.05$) improvement occurred in WDA at approximately one year of age. There was a decrease for this trait in males in 19 (66%) of the Hereford herds and three (21%) of the Angus herds; significant ($P < 0.05$) decreases occurred in six (20%) of the Hereford herds. There was no significant ($P < 0.05$) decline in

males in Angus herds for the WDA trait.

For females, improvement in WDA occurred in 15 (52%) of the Hereford herds and 11 (79%) of the Angus herds. This improvement was significant ($P < 0.05$) in females in one (3%) of the Hereford herds and four (29%) of the Angus herds. Female WDA decreased in 14 (48%) of the Hereford herds and three (21%) of the Angus herds; significant ($P < 0.05$) decreases were found in four (14%) of the Hereford herds and one (7%) of the Angus herds.

Table 15. Number of herds with positive and negative regressions of weight-per-day of age over years

Value of Regression Coefficient	Number of Hereford Herds		Number of Angus Herds	
	M	F	M	F
Positive b Value *	1	1	2	4
Positive b Value NS	9	14	9	7
Subtotal	10	15	11	11
Negative b Value *	6	4	0	1
Negative b Value NS	13	10	3	2
Subtotal	19	14	3	3
Total	29	29	14	14

* Regression significantly different from zero at ($P < 0.05$)

NS Regression not significantly different from zero at ($P < 0.05$)

The average across-herd regression coefficient for weight-per-day of age was -0.004 ± 0.023 and -0.000 ± 0.020 lb. per day per year in males and in females respectively.

E. Estimation of Change in Production Traits Over Years in One Research and Two Commercial Beef Cattle Herds in Alberta

Using data on two herds over nine years from the report of Berg and McElroy (1968) positive regression coefficients were obtained for all traits except for Hybrid male birth weights indicating that the weight traits have responded readily to selection in Hereford and Hybrid cattle (Table 16).

Adjusted 180-day weight increased by 4.4 lb. per year in both lines of males, while Hereford female 180-day weights increased by 2.3 lb. per year and Hybrid female 180-day weights increased by 3.9 lb. per year during the 9-year period from 1961 to 1969. Over nine years of the program, 365-day weight increased by 53.8, 54.7, 14.4 and 13.4 lb. per year in Hereford and Hybrid males and females respectively. Beginning in 1965 male calves were put on heavy feed following weaning and therefore the marked improvement in yearling weight in males was to a large extent due to improved management.

An analysis of records from Commercial Ranch A where rapid growth rate was the main criterion for selection in a closed herd of Angus cattle showed that weaning weights at 205 days improved 5.3 and 4.7 lb. per year in heifers and bulls, respectively, during the 13-year period from 1957 to 1969 (Table 17). Some crossbreeding using bulls of the Charolais breed was practiced during the later years of this selection program.

Table 16. Weights and adjusted weights of Hereford and Hybrid line calves born 1961 to 1969 Kinsella³

Sex	Breed		1961	1962	1963	1964	1965	1966	1967	1968	1969 ⁴	b Value ⁵
	Line											
<u>Birth wt. lb.</u>												
M	He		71	75	77	75	74	78	75	77	0.52	
	Hy		79	80	80	78	76	78	75	81	-0.23	
	Diff. ¹		+8	+5	+3	+3	+2	0	0	+4		
F	He		70	70	74	71	69	71	71	71	0.01	
	Hy		68	71	78	74	75	75	71	73	0.32	
	Diff.		-2	+1	+4	+3	+6	+4	0	+2		
<u>Adjusted² 180-day wt. lb.</u>												
M	He		422	341	390	401	343	400	381	455	407	4.38
	Hy		453	457	465	445	428	467	456	491	492	4.37
	Diff.		+31	+116	+75	+44	+85	+67	+75	+36	+85	
F	He		402	367	350	368	332	386	372	420	381	2.28
	Hy		424	421	418	426	398	446	417	451	456	3.93
	Diff.		+22	+54	+68	+58	+66	+60	+45	+31	+75	
<u>365-day wt. lb.</u>												
M	He		591	526	585	637	710	853	892	937	882	53.78
	Hy		617	653	647	689	785	940	967	957	987	54.72
	Diff.		+26	+127	+62	+52	+75	+87	+75	+20	+105	
F	He		515	504	515	562	569	656	613	616	574	14.37
	Hy		569	544	471	610	613	708	671	647	619	13.45
	Diff.		+54	+40	+56	+48	+44	+52	+58	+31	+45	
<u>540-day wt. lb.</u>												
F	He		745	745	768	770	785	814	810	830		12.77
	Hy		794	805	818	838	826	887	878	871		13.08
	Diff.		+49	+60	+50	+68	+41	+73	+68	+41		

1 Differences - Hybrid minus Hereford

2 Adjusted for age of calf and age of dam

3 Source: Berg and McElroy (1968)

4 Source: Berg (1970)

5 b Value - regression of animal weight in lb. over years

Table 17. Average weight-per-day of age at weaning of Angus and crossbred calves born 1957 to 1969 - Commercial Ranch A

Year	Heifers		Bulls		Steers	
	No.	Ave.	No.	Ave.	No.	Ave.
1957	38	1.95	46	2.04	0	0.00
1958	59	1.65	72	1.79	0	0.00
1959	81	2.02	86	2.30	0	0.00
1960	132	2.18	153	2.37	0	0.00
1961	165	2.12	122	2.25	0	0.00
1962	136	2.05	160	2.24	1	1.68
1963	171	2.14	64	2.33	113	2.28
1964	205	2.10	197	2.25	0	0.00
1965	176	2.06	182	2.15	4	2.09
1966	213	2.04	222	2.16	0	0.00
1967	253	2.22	251	2.38	2	2.59
1968	256	2.18	283	2.34	0	0.00
1969	253	2.34	276	2.49	0	0.00
Totals	2,138		2,114		120	
b Values ¹		0.029		0.027		

¹b Values - regression of weight-per-day of age at weaning over years

Using weaning weight data from Commercial Ranch B, weights at weaning adjusted to 205 days increased by 4.1, 6.4 and 6.1 lb. per year in heifers, bulls and steers respectively (Table 18). The improvement program here was based on selection for high growth rate and on crossbreeding. During the first years of this beef cattle breeding program, cattle of the Hereford breed predominated. In subsequent years, crossbreeding was extensively practiced using bulls of the Angus, Red Angus and Charolais breeds. At this same time, bulls of the Brown Swiss and Shorthorn breeds were used to a lesser extent. During 1967 and 1968, bulls of the Simmental and Limousin breeds were used quite extensively. A sharp decline in the level of management of heifer calves occurred during 1968 and 1969 and therefore the decline in heifer weight-per-day of age at weaning was to a large extent due to a decrease in the level of management.

Table 18. Average weight-per-day of age at weaning of Hereford and crossbred calves born 1957 to 1969 - Commercial Ranch B

Year	Heifers		Bulls		Steers	
	No.	Ave.	No.	Ave.	No.	Ave.
1957	83	1.69	0	0.00	69	1.83
1958	117	1.63	0	0.00	95	1.77
1959	88	1.86	9	2.20	62	1.88
1960	119	1.80	9	2.03	95	1.84
1961	114	1.82	7	2.12	105	1.90
1962	118	1.90	1	2.62	109	1.92
1963	128	1.87	1	2.07	147	1.95
1964	130	2.01	0	0.00	124	2.18
1965	140	1.83	1	2.50	127	1.98
1966	113	1.84	4	2.12	121	1.89
1967	180	2.11	37	2.64	160	2.18
1968	162	1.88	185	2.43	0	0.00
1969	162	1.88	170	2.40	0	0.00
Totals	1,654		424		1,214	
b Values ¹		0.020		0.031		0.030

¹b Values - regression of weight-per-day of age at weaning over years

DISCUSSION AND APPLICATIONS

The Federal-Provincial Beef Cattle Performance Testing Program in Alberta has not been as successful as was anticipated at the time of its inauguration in 1959. In the regression over years of the performance of 43 herds involved in the program from five to eleven years for preweaning ADG, end-of-test conformation score, post-weaning ADG and weight-per-day of age, it was found that only conformation score taken at the time of the end-of-test weighing had shown acceptable response. However, a comparison between a preliminary analysis of results up to 1967 (Appendix A, Tables 5, 6 and 7) and the complete analysis of results to date shows some evidence of improvement occurring in production traits in many of the herds over the period 1967 through 1969.

For males, the number of herds showing improvement in preweaning ADG increased from four to seven in the 29 Hereford herds and from seven to 10 in the 14 Angus herds. For post-weaning ADG, the number of Hereford herds showing improvement increased from 15 to 16; this increase was from 11 to 12 in the Angus breed. The WDA trait showed the greatest amount of improvement in both breeds. Hereford herds showing improvement in male WDA increased from one to 10 and Angus herds improving in this trait increased from three to 11. For females, the trend was similar to that in males. Female preweaning ADG improved over years in nine as compared to three Hereford herds and nine as compared to four Angus herds. For female post-weaning ADG, the number of Hereford herds showing improvement increased to 18 from 14 and to 11 from nine in Angus herds. The number of herds showing improvement in female WDA increased to 15 from one in the Hereford breed and to 11 from two in the Angus breed. As the evaluation

of animals for conformation was discontinued in 1966, no comparisons can be made for this trait.

The declining performance of beef cattle which result in less economic cattle as described by Knox (1957) and Warwick (1958) only accentuates the necessity for early and regular evaluation of all beef cattle performance testing programs. In doing this, it should be possible to avert any serious trends which may be occurring. Analysis of data on weaning weight of fall feeder calf sales from 1946 to 1965 (Appendix A, Table 8) showed that steer calves declined 0.94 lb. per year and heifer calves declined 1.08 lb. per year over the 20-year period. This trend could be one that is widespread throughout the cattle industry in Western Canada.

Significant ($P < 0.05$) increases were made in male preweaning ADG in two Hereford herds identified by R10 and SBF and Angus herd identified by DHR improved by 7.2, 6.2 and 9.0 lb. per year respectively over 11, 11 and seven years respectively. Only the females in Hereford herd SBF and Angus herd DHR showed significant ($P < 0.05$) improvement. This rate of increase amounted to 4.5 lb. over 11 years and 8.0 lb. in seven years for the Hereford and Angus herds respectively. Weaning weights have been reported to be only moderately heritable by many researchers (Warwick, 1958; Swiger et al., 1963; Brown and Gacula, 1964; Swiger et al., 1965; Marlowe and Vogt, 1965; Deese and Koger, 1967). However, several instances have been reported where selection for weaning weight in beef calves has been effective (Flower et al., 1964; Nelms et al., 1967; Chapman et al., 1969).

Results obtained in the study of change in 180-day weaning weight

over years at the University of Alberta Beef Cattle Research Ranch at Kinsella and of change in 205-day weaning weight over years at Commercial Ranches A and B suggest that the response of weaning weight to selection, crossbreeding and improved management over time is quite acceptable. At the Kinsella ranch, both lines showed similar improvement in weaning weights over time. The Hybrid line began the selection program having a marked advantage in the weight traits over the Hereford line and maintained this advantage throughout the period of selection experiment. Results to date indicate that selection for the weight traits is equally as effective in crossbred cattle as it is in purebred cattle and that the advantage in weight gained during crossbreeding can be retained. More research is needed in the area of crossbreeding within selection programs to accurately determine the complementary and overall effect of the two concepts in beef cattle improvement.

For post-weaning ADG, only the males in three Hereford herds and three Angus herds and the females in five Hereford herds and three Angus herds improved at a level that was significant ($P < 0.05$). The males in Hereford herds identified by BKP, GDT and IAY and Angus herds identified by FHR, GBG and MN improved post-weaning ADG on a 168-day test by 7.7, 6.6, 16.5, 11.1, 10.1 and 8.1 lb. per year respectively over the number of years on test. The females in Hereford herds identified by AET, BKP, DSF, IAY and MCI and Angus herds identified by AYE, MN and VN improved in the post-weaning ADG trait at a level that was significant ($P < 0.05$). Post-weaning ADG has been reported by many researchers to be quite high in heritability and should respond readily to selection (Warwick, 1958; Brinks et al., 1962; Swiger et al., 1963; Shelby et al., 1963; Brown and Gacula, 1964; Swiger et al., 1965). Nelms et al. (1967) reported a 0.25

lb. per year increase in gain-per-day on feed test. It is possible to conclude that selection for post-weaning ADG should be quite effective in improving this trait.

For the weight-per-day of age trait, only the males in Hereford herd identified by GUR and the males in Angus herds identified by GBG and VN improved over years at a significant ($P < 0.05$) level. This improvement amounted to 42.7, 26.6 and 20.1 for the three herds respectively. Improvement in female WDA occurred in Hereford herd identified by GUR and Angus herds identified by CCE, GBG, MN and VN at a level that was significant ($P < 0.05$).

Weight-per-day of age has been reported to be quite highly heritable (Brinks et al., 1962; Swiger et al., 1963; Shelby et al., 1963, Swiger et al., 1965). When selecting for weight-per-day at one year of age, many researchers report quite acceptable response over years (Nelms et al., 1967; Rahnefeld, 1968; Newman, 1969). Using the data on 365-day weight in two lines of beef cattle from Berg and McElroy (1968), relatively high positive regression coefficients were obtained for this trait over years.

Conformation score taken at the time of the end-of-test weighing was the only trait that showed acceptable response. There were no herds in which there was a significant ($P < 0.05$) decrease in conformation score over years. It appears that, either breeders were emphasizing type almost to the total exclusion of the growth traits in their selection of replacement breeding stock or the officials assessing the conformation of the cattle had become more lenient in their scoring of the conformation trait.

Research has indicated that type is of undetermined importance, especially in the areas of consumer acceptance and utility (Knox, 1957). Selection pressure on the growth traits would increase the efficiency of production. This approach would seem to be more realistic than the selection for conformation score which may well prove to be entirely unimportant in the near future.

Selection for several traits reduces the pressure applied to each one. Botkin and Stratton (1967) found that breeders of purebred sheep are constantly faced with the problem of selecting for many characters that are not necessarily related to production. In the selection for improvement of weaning weight and fleece weight in two small flocks of purebred sheep, over 50% of the lambs were not eligible for registration because they possessed traits that were not characteristic of the breed. The level of performance in the production traits of these disqualified lambs was equivalent to that of the lambs acceptable for registration. The purebred beef cattle breed organizations have similar restrictions which may prohibit registration of animals with complete disregard to any outstanding performance in the weight traits. Selection in all classes of purebred livestock should be directed toward simple and accurate standards of values for production traits.

Lush (1945) stated that when culling simultaneously for n independent and equally important traits, selection for each trait will be $1/\sqrt{n}$ as intense as if all the efforts of selection could be concentrated on that single trait. Thus, in a 12-trait selection program, selection for each trait would only be 29% as intense for any particular trait as it would be if selection were for that one trait alone. Peters et al. (1961) reported that, in sheep, the selection for more than a dozen

traits during the development of the Romnelet breed greatly limited the amount of selection pressure that could be applied to any one trait. Selection for only those traits with considerable economic value is suggested.

Many factors contribute to the failure of many of the herds on the ROP testing programs to give results equivalent to those made in various research studies. These are as follows:

(1) The majority of the emphasis in the selection of replacement bulls and heifers may have been placed on conformation score rather than weaning weight index, feedlot gain index or WDA index. This was evident to some extent in Hereford herds identified by BVZ, BBF, BGN, ASL, IBO, MCI and XUB and Angus herds identified by VN, CMA, BBP, BC and CCE (Appendix A, Table xxi).

(2) There was evidence of a greater amount of creepfeeding of calves in the initial years of testing. This added environmental factor would increase weaning weights to levels not obtainable without the use of creepfeeding. In the following years when creepfeeding was not practiced, weaning weights and feedlot weights would tend to decrease. The effect of creepfeeding trend on male preweaning average daily gain over years is shown in Table 19. It was found that seven herds that had a positive regression coefficient of preweaning ADG over years had a constant level of creepfeeding or non-creepfeeding, nine herds that improved had a declining creepfeeding trend and one herd had an increasing creepfeeding trend. For those herds that had a negative regression coefficient for preweaning ADG over years, eleven also showed a declining

Table 19. Effect of creepfeeding trend on male preweaning ADG over years

Herd Identification and lb Value		Creepfeeding Trend
H-RIO	0.035*	0
H-SBF	0.030*	-
A-DHR	0.044*	0
H-AET	0.006	-
H-BKP	0.015	-
H-BVZ	0.006	+
H-DEE	0.021	-
H-IBO	0.008	-
A-CCE	0.010	-
A-CMA	0.013	0
A-FHR	0.014	0
A-GBG	0.009	-
A-JST	0.009	-
A-MN	0.011	0
A-OAF	0.008	0
A-TLT	0.030	-
A-VN	0.020	0
H-AAIN	-0.203*	-
H-ASL	-0.133*	-
H-BBF	-0.032*	-
H-BGN	-0.044*	0
H-HDA	-0.019*	-
H-IAY	-0.049*	+
H-UP	-0.059*	0
H-ARJ	-0.001	+
H-BSB	-0.070	-
H-BZD	-0.021	-
H-DSF	-0.001	0
H-ETU	-0.031	0
H-EZC	-0.010	0
H-FSI	-0.024	+
H-GDT	-0.027	-
H-GUR	-0.002	0
H-JNT	-0.003	0
H-MCI	-0.007	0
H-MFM	-0.009	+
H-OHB	-0.029	0
H-OTH	-0.037	-
H-XUB	-0.013	+
A-AYE	-0.019	-
A-BBP	-0.003	-
A-BC	-0.042	0
A-DHV	-0.011	-

1 the regression of male preweaning ADG over years

0 a constant creepfeeding trend over years

- a declining creepfeeding trend over years

+ an increasing creepfeeding trend over years

level of creepfeeding, five showed an improving creepfeeding trend and in ten herds no change in creepfeeding practice over years was evident.

(3) There was very little evidence in many herds of older sires being replaced by young, high indexing sires from within the herd or the ROP program. A summary of the use of sires within herds where final WDA improved or declined over years is shown in Table 20. Nine herds in which a positive regression coefficient of male WDA over years existed showed evidence of much use of high performing sires, six herds showed moderate use and in eight herds there was minimal or no use of high performing sires. There were 20 of the herds which showed a negative regression coefficient of male WDA over years on test. None of these 20 herds showed evidence of a great amount of use of high performing sires; eight showed only moderate use of high indexing sires and 12 herds showed minimal or no use of high performing sires.

(4) There was much evidence of sires being used for a larger number of years than is desirable. The average age at time of breeding of 504 sires in the 23 herds where male WDA improved over years was 3.5 years as compared to 4.3 years on 452 sires in the 20 herds where male WDA declined over years. An individual sire that was used every year for a period of five years, for example, would be counted as five sires in this part of the study. The average age of sires at time of breeding in Hereford herds identified by AAIN, ASL and DSF and Angus herd identified by CMA were 7.7, 8.4, 6.4 and 5.4 years respectively. Hereford herds identified by BKP, BVZ, BSB, ETU, EZC, HDA, ARJ, BBF, BGN, DSF, FSI, GDT, IBO, MCI, OHB, OTH, UP and XUB all used at least one of their herd sires for five years or more.

Table 20. Evidence of use of high indexing sires on male WDA over years

Herd Identification and ¹ b Value		^a High	^b Moderate	^c Low
H-GUR	0.117*	X		
A-GBG	0.073*			X
A-VN	0.055*			X
H-AET	0.019			X
H-BKP	0.026	X		
H-BSB	0.001			X
H-BVZ	0.030			X
H-DEE	0.010		X	
H-ETU	0.033		X	
H-EZC	0.046			X
H-HDA	0.021		X	
H-IAY	0.002			X
H-MFM	0.007			X
H-RIO	0.011	X		
A-AYE	0.005		X	
A-CMA	0.005		X	
A-DHR	0.046	X		
A-DHV	0.005	X		
A-FHR	0.027	X		
A-JST	0.038		X	
A-MN	0.018	X		
A-OAF	0.016	X		
A-TLT	0.011	X		
H-AAIN	-0.100*			X
H-ARJ	-0.043*			X
H-BBF	-0.033*		X	
H-BGN	-0.084*			X
H-BZD	-0.063*			X
H-JNT	-0.048*			X
H-ASL	-0.022			X
H-DSF	-0.002		X	
H-FSI	-0.017		X	
H-GDT	-0.027		X	
H-IBO	-0.010			X
H-MCI	-0.000		X	
H-OHB	-0.024			X
H-OTH	-0.042			X
H-SBF	-0.009			X
H-UP	-0.008		X	
H-XUB	-0.015		X	
A-BBP	-0.019			X
A-BC	-0.047			X
A-CCE	-0.019			X

1 the regression of male WDA over years

a high, much use of high indexing sires

b moderate, some use of high indexing sires or much use of lower indexing sires

c low, no use of performance tested sires or use of very low indexing sires

(5) The rapid expansion of cow herds in the early stages of the program could have included lower indexing heifers from the herd of the breeder or purchased from other breeders which would not normally be kept as replacements. Yearly increases in herd size for each herd are shown in Appendix A, Table 10. Hereford herds identified by GUR, HDA, AAIN, ARJ and UP increased 8.3, 6.7, 8.5, 10.5 and 6.7 animals respectively per year on test. Although expansion of cow herds probably was a factor affecting the rate of improvement in individual herds, the average increase in herd size per year for the 23 herds where male WDA improved over years on test was 3.0 animals per herd as compared to 2.0 animals per herd in the 20 herds where male WDA over years on test did not improve.

(6) There were some herds which showed a complete lack of the use of performance tested bulls. Hereford herds identified by AET, BSB, IAY, AAIN, ARJ, BZD, JNT and OHB fell into this category. There were no Angus herds that had not made use of performance tested bulls at least to some extent.

(7) The placing of too much emphasis on breed characteristics such as coat color and horns could limit selection for performance characteristics. Two instances were found in the field records where Hereford heifers were not registered because of improper color markings although they had shown quite acceptable performance for the growth traits.

(8) The number of years of testing in some herds may have been insufficient to expect much response to date.

Improvement in production traits in beef cattle can be brought about in three ways; improvement in management, selection of superior breeding stock and by crossbreeding. Records provided by the ROP program should

make it possible for participants to know if they are making progress although the relative importance of management and breeding may not be apparent. No progress can be expected unless a conscious effort is made on the part of the breeder to either improve management or select breeding stock on the basis of records. It is obvious from this study that a majority of the breeders on the program have either not made the effort or have not had sufficient time in which to make effective improvement in the productivity of their herds.

The need to regularly examine performance testing programs on the basis of merit and potential value to the total future of the industry cannot be over-emphasized. The results of the evaluation of the ROP testing program in Alberta tend to indicate the lack of or improper use of records in most instances. The following recommendations can be made based on the findings of this study.

(1) Breeders and producers should be provided with appropriate consulting services on the use of records by highly trained government or private personnel who should endeavor to capture every opportunity to exploit their ideas.

(2) The indexes of the sire and dam should be included on worksheets and in summaries so that the breeder can more easily see the effects of mating individuals with certain indexes for the weight traits.

(3) The relative emphasis given to each of the traits in record of performance programs for beef cattle should be critically evaluated. Weight-per-day of age at one year in bulls and at 18 months in heifers should be stressed.

(4) The post-weaning gain test should be carried out only under a full-feeding nutritional level. According to Marlowe (1962), animals with a high growth potential will not perform at a level superior to those animals with a lower potential if the quality and quantity of feed is less than desirable.

(5) Many beef cattle performance testing programs are known as beef cattle improvement programs. This latter title suggests the performance testing of animals but also indicates using the high performers for further improvement within the herd. Beef cattle improvement starts immediately after the cattle are weighed.

(6) A periodic evaluation of the methods of selection of replacement stock by individual participants on the performance testing program would be desirable. It should be possible at this time to avert any serious trends in performance in a herd. After sufficient counselling and a given time period, any participants who do not attempt to adhere to the basic principles behind the performance testing of beef cattle should be stricken from the program. The efforts of professional personnel could then be concentrated more intensely on those breeders who are seriously interested in the betterment of their cattle herd.

More research is needed regarding the procedures involved in carrying out an effective program for the development of beef cattle herds with a high economic value. The improvement of beef cattle is a great and interesting challenge for both breeders and government extension and research personnel. The long-term success of any cattle breeding establishment will be in its ability to accurately identify and retain in the breeding herd genetically superior animals.

SUMMARY AND CONCLUSIONS

The regression of male preweaning ADG over years in the 43 herds showed a significant ($P < 0.05$) improvement in only three herds. The males in seven herds showed a significant ($P < 0.05$) decline for this trait. For females, two herds showed a significant ($P < 0.05$) improvement in preweaning ADG and six herds showed a significant ($P < 0.05$) decline. The average across-herd regression coefficient in males and in females respectively was -0.014 and -0.012 lb. per day per year.

The regression of male conformation score over years in the 43 herds showed that 11 herds were significantly ($P < 0.05$) improved. In females, eight herds improved at a level that was significant ($P < 0.05$). There was no significant ($P < 0.05$) decline in conformation score in either sex in the herds under evaluation. The average across-herd regression coefficient for conformation score was found to be 0.043 and 0.026 grades per year in males and in females respectively.

When post-weaning ADG was regressed over years, the males in only six of the 43 herds showed a level of improvement that was significant ($P < 0.05$). The males in three herds showed a significant ($P < 0.05$) decline in performance in this trait. The regression of female post-weaning ADG over years showed eight herds improving significantly ($P < 0.05$). No herds of females declined significantly ($P < 0.05$) in post-weaning performance. The average across-herd regression coefficient for this trait was 0.015 and 0.020 lb. per day per year in males and in females respectively.

The regression of male weight-per-day of age taken at the end of

the feed test period over years showed that significant ($P < 0.05$) improvement occurred in only three herds. Six male herds declined significantly ($P < 0.05$) for this trait. Significant ($P < 0.05$) improvement occurred in this trait in females in five herds; five herds of females declined significantly ($P < 0.05$) for the weight-per-day of age trait. The average across-herd regression coefficient for this trait was -0.004 and -0.000 lb. per day per year in males and in females respectively.

Satisfactory trends were found in the production traits in the University of Alberta beef cattle herd at Kinsella and at Commercial Ranches A and B in the regression of these traits over years.

Any performance testing program is only as good as the degree to which the resulting information is used effectively. The Federal-Provincial Record of Performance Testing Program for beef cattle in Canada is basically a sound method for evaluating the growth performance of animals within the same herd. Participating breeders should be encouraged to use these records intelligently when selecting herd replacements. This would make it possible to obtain results similar to those obtained in beef cattle improvement programs by both private industry and research establishments.

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APPENDIX A

Table 1. Card layout form of the weaning card

Field Sequence	Detail	Columns		No. of Columns
		Start	Finish	
1	Card code (1).....	1	1	1
2	Owner.....	2	4	3
3	Province.....	5	5	1
4	Breed code.....	6	6	1
5	Creep fed (alpha X) or non creep fed (blank).....	7	7	1
6	205 day weight.....	8	10	3
7	% of national index.....	11	13	3
8	Group within herd index.....	14	16	3
9	Dam age			
	years.....	17	18	2
	days.....	19	21	3
10	Dam herd character.....	22	25	4
11	Dam number and year letter.....	26	29	4
12	Sire herd character.....	30	33	4
13	Sire number and year letter.....	34	37	4
14	Calf herd character.....	38	41	4
15	Calf number and year letter.....	42	45	4
16	Sex.....	46	46	1
17	Birth date.....	47	51	5
18	Birth weight.....	52	54	3
19	Weaned date.....	55	59	5
20	Weaned group.....	60	60	1
21	Weaned sub-group.....	61	61	1
22	Blank.....	62	62	1
23	Weaned weight.....	63	65	3
24	Type code.....	66	66	1
25	Feed group.....	67	67	1
26	Feed sub-group.....	68	68	1
27	Gain to weaning.....	69	71	3
28	Age of calf when weaned.....	72	74	3
29	Average daily gain to weaning....	75	77	3
30	Adjusted average daily gain..... (adjusted for dam age)	78	80	3

Table 2. Card layout form of the feed card

Field Sequence	Detail	Columns		No. of Columns
		Start	Finish	
1	Card code (2).....	1	1	1
2	Owner.....	2	4	3
3	Province.....	5	5	1
4	Breed code.....	6	6	1
5	Creep fed (alpha X) or non creep fed (blank).....	7	7	1
6	Blank.....	8	12	5
7	Sire registration number.....	13	21	9
8	Dam herd character.....	22	25	4
9	Dam number and year letter.....	26	29	4
10	Sire herd character.....	30	33	4
11	Sire number and year letter.....	34	37	4
12	Calf herd character.....	38	41	4
13	Calf number and year letter.....	42	45	4
14	Sex.....	46	46	1
15	Weaned date.....	47	51	5
16	Weaned weight.....	52	54	3
17	End of test date.....	55	59	5
18	Group.....	60	60	1
19	Sub-group.....	61	61	1
20	End of feed test weight.....	62	65	4
21	Type.....	66	66	1
22	Group.....	67	67	1
23	Sub-group.....	68	68	1
24	Gain on feed calculated.....	69	71	3
25	Age - calculated (days on feed)...	72	74	3
26	Average daily gain on feed - calculated.....	75	77	3
27	Rate of gain on feed index - calculated.....	78	80	3

Table 3. Card layout form of the final test card

Field Sequence	Detail	Columns		No. of Columns
		Start	Finish	
1	Card code (3).....	1	1	1
2	Owner.....	2	4	3
3	Province.....	5	5	1
4	Breed code.....	6	6	1
5	Creep fed (alpha X) or non creep fed (blank).....	7	7	1
6	Calculated rate of gain index....	8	10	3
7	Blank.....	11	11	1
8	Used for calc (1) if gain over 999.....	12	12	1
9	Dam registration number.....	13	21	9
10	Dam herd character.....	22	25	4
11	Dam number and year letter.....	26	29	4
12	Sire herd character.....	30	33	4
13	Sire number and year letter.....	34	37	4
14	Calf herd character.....	38	41	4
15	Calf number and year letter.....	42	45	4
16	Sex.....	46	46	1
17	Birth date.....	47	51	5
18	Birth weight.....	51	54	3
19	End of test date.....	55	59	5
20	Group.....	60	60	1
21	Sub-group.....	61	61	1
22	End of feed test weight.....	62	65	4
23	Type.....	66	66	1
24	Group.....	67	67	1
25	Sub-group.....	68	68	1
26	Calculated gain from birth.....	69	71	3
27	Calculated age from birth.....	72	74	3
28	Age at end of test (calculated)..	75	77	3
29	Calculated rating.....	78	80	3

Table 4. Combined card to tape layout form

Field Sequence	Detail	Columns		No. of Columns
		Start	Finish	
1	Owner.....	1	3	3
2	Province.....	4	4	1
3	Breed code.....	5	5	1
4	Creep fed (alpha X) or non creep fed (blank).....	6	6	1
5	205 day weight.....	7	9	3
6	% of national index.....	10	12	3
7	Group within herd index.....	13	15	3
8	Dam age			
	years.....	16	17	2
	days.....	18	20	3
9	Dam herd character.....	21	24	4
10	Dam number and year letter.....	25	28	4
11	Sire herd character.....	29	32	4
12	Sire number and year letter.....	33	36	4
13	Calf herd character.....	37	40	4
14	Calf number and year letter.....	41	44	4
15	Sex.....	45	45	1
16	Birth date.....	46	50	5
17	Birth weight.....	51	53	3
18	Weaned weight.....	54	58	5
19	Weaned group.....	59	59	1
20	Weaned sub-group.....	60	60	1
21	Blank.....	61	61	1
22	Weaned weight.....	62	64	3
23	Type code.....	65	65	1
24	Feed group.....	66	66	1
25	Feed sub-group.....	67	67	1
26	Gain to weaning.....	68	70	3
27	Age of calf when weaned.....	71	73	3
28	Average daily gain to weaning....	74	76	3
29	Average daily gain to weaning (adjusted for dam age).....	77	79	3
30	Calf herd character.....	80	83	4
31	End of feed test weight.....	84	87	4
32	Type.....	88	88	1
33	Gain on feed - calculated.....	89	91	3
34	Days on feed - calculated.....	92	94	3
35	Average daily gain on feed - calculated.....	95	97	3
36	Calf herd character.....	98	101	4
37	End of feed test weight.....	102	105	4
38	Gain from birth - calculated.....	106	108	3
39	Age at end of test (days) - calc.	109	111	3
40	Average daily life-time gain.....	112	114	3

Table 5. Number of herds with positive and negative regressions of preweaning average daily gain over years to 1967

Value of Regression Coefficient	Number of Hereford Herds		Number of Angus Herds	
	M	F	M	F
Positive b Value *	1	0	1	2
Positive b Value NS	3	3	6	2
Subtotal	4	3	7	4
Negative b Value *	11	5	1	4
Negative b Value NS	14	21	6	6
Subtotal	25	26	7	10
Total	29	29	14	14

* Significant ($P < 0.05$)

NS Not Significant ($P < 0.05$)

Table 6. Number of herds with positive and negative regressions of post-weaning average daily gain over years to 1967

Value of Regression Coefficient	Number of Hereford Herds		Number of Angus Herds	
	M	F	M	F
Positive b Value *	3	4	1	0
Positibe b Value NS	12	10	10	9
Subtotal	15	14	11	9
Negative b Value *	4	0	0	1
Negative b Value NS	10	15	3	4
Subtotal	14	15	3	5
Total	29	29	14	14

* Significant ($P < 0.05$)

NS Not Significant ($P < 0.05$)

Table 7. Number of herds with positive and negative regressions of weight-per-day of age over years to 1967

Value of Regression Coefficient	Number of Hereford Herds		Number of Angus Herds	
	M	F	M	F
Positive b Value *	0	0	0	0
Positive b Value NS	1	1	3	2
Subtotal	1	1	3	2
Negative b Value *	14	7	2	3
Negative b Value NS	14	21	9	9
Subtotal	28	28	11	12
Total	29	29	14	14

* Significant ($P < 0.05$)

NS Not Significant ($P < 0.05$)

Table 8. Weight of weanling steer and heifer calves at Walsh and Moose Jaw fall feeder calf sales from 1946 to 1965

Year	Weight of Steers	Weight of Heifers
1946	392	363
1947	402	386
1948	410	384
1949	373	367
1950	416	375
1951	416	391
1952	394	371
1953	407	359
1954	403	346
1955	414	397
1956	386	353
1957	377	346
1958	396	365
1959	395	370
1960	399	366
1961	381	353
1962	382	345
1963	387	355
1964	397	378
1965	379	358
Average	395	366
¹ b Value	-0.94	-1.08

¹ the regression of fall weanling weight over years

Table 9. Use of the creepfeeding^a practice in calves
prior to weaning by year

Herd	Year											b Value
	59	60	61	62	63	64	65	66	67	68	69	
H-AAIN	-	-	-	2	2	2	2	1	-	-	-	-0.20
H-AET	2	2	1	2	2	1	1	1	2	2	-	-0.02
H-ARJ	1	1	1	1	2	2	1	1	1	1	2	0.04
H-ASL	-	-	-	-	2	1	1	1	-	-	-	-0.30
H-BBF	2	2	1	1	1	1	1	1	1	1	1	-0.08
H-BGN	1	1	1	1	1	1	1	1	1	-	-	0.00
H-BKP	2	2	1	1	1	1	1	1	1	1	1	-0.08
H-BSB	2	2	2	2	2	2	1	1	2	2	1	-0.07
H-BVZ	-	-	-	-	1	1	1	1	1	2	1	0.07
H-BZD	2	2	2	2	2	1	1	1	1	-	-	-0.17
H-DEE	2	2	2	1	2	2	2	2	2	1	1	-0.06
H-DSF	2	1	1	1	1	1	1	1	1	1	2	0.00
H-ETU	-	-	-	1	1	1	1	1	1	1	-	0.00
H-EZC	-	-	-	-	1	1	1	1	1	1	1	0.00
H-FSI	-	-	-	1	1	1	1	1	1	2	2	0.14
H-GDT	2	1	1	1	1	1	1	1	1	1	1	-0.04
H-GUR	-	-	-	-	1	1	1	1	1	1	1	0.00
H-HDA	-	-	-	-	1	2	1	1	1	-	1	-0.07
H-IAY	1	1	1	1	1	1	1	2	2	2	2	-0.13
H-IBO	1	1	1	1	2	1	1	1	1	1	1	-0.01
H-JNT	2	2	2	2	2	2	2	2	2	2	2	0.00
H-MCI	1	1	1	1	1	1	1	1	1	1	1	0.00
H-MFM	1	1	2	1	1	1	1	1	1	2	2	0.05
H-OHB	1	1	1	1	1	1	1	1	1	-	-	0.00
H-OTH	-	-	-	1	2	2	2	2	1	1	1	-0.09
H-RIO	1	1	1	1	1	2	1	1	1	1	1	0.00
H-SBF	2	1	1	1	1	1	1	1	1	1	1	-0.04
H-UP	-	-	-	-	1	1	1	1	1	1	1	0.00
H-XUB	1	1	2	2	2	2	2	2	2	2	2	0.08
A-AYE	1	1	1	1	2*	2	1	1	1	1	1	-0.00
A-BBP	2	2	1	1	1	1	1	1	1	1	1	-0.08
A-BC	1	1	1	1	1	1	1	1	1	1	-	0.00
A-CCE	2	1	1	1	1	1	1	1	1	1	-	-0.04
A-CMA	1	1	1	1	1	1	1	1	1	1	1	0.00
A-DHR	-	-	-	-	1	1	1	1	1	1	1	0.00
A-DHV	2	2	1	1	2*	2	1	1	1	1	2	-0.04
A-FHR	-	-	-	-	1	1	1	1	1	1	-	0.00
A-GBG	-	-	-	-	2	2	2	1	1	1	1	-0.21
A-JST	-	-	-	2	1	1	1	1	1	1	1	-0.08
A-MN	2*	2*	1	2*	2*	1	1	1	2*	2*	2*	0.00
A-OAF	2	2	-	2	2	2	2	2	2	2	2	0.00
A-TLT	2	2	2	1	1	2	1	1	1	1	1	-0.11
A-VN	-	-	-	-	1	1	1	1	1	1	1	0.00

^a a supplementary grains and forage in addition to regular available feed

1 creepfeeding not used

2 creepfeeding used

* creepfeeding used on male calves only

Table 10. Total number of calves weighed at weaning in each herd by year

Herd	Year											lb Value
	59	60	61	62	63	64	65	66	67	68	69	
H-AAIN	-	-	-	23	30	35	49	56	-	-	-	8.5
H-AET	18	12	20	18	17	19	17	19	17	25	25	0.7
H-ARJ	8	23	41	43	43	2	83	94	121	99	102	10.5
H-ASL	-	-	-	-	85	107	123	149	5	-	-	-11.8
H-BBF	13	16	18	17	22	31	31	32	34	35	41	2.8
H-BGN	14	23	21	27	28	15	13	22	20	-	-	-0.1
H-BKP	23	28	40	45	41	45	57	58	72	55	70	4.4
H-BSB	6	6	8	12	25	19	26	18	35	11	-	2.0
H-BVZ	-	-	-	-	62	61	57	58	52	59	50	-1.6
H-BZD	11	14	17	22	12	17	17	6	6	-	-	-0.8
H-DEE	8	23	19	20	19	24	39	47	21	31	31	2.1
H-DSF	26	38	39	43	35	60	63	62	57	51	59	3.1
H-ETU	-	-	-	-	45	44	71	-	64	53	-	2.4
H-EZC	-	-	-	-	27	30	41	43	41	51	-	4.4
H-FSI	-	-	-	25	20	20	35	38	39	53	58	5.4
H-GDT	26	35	33	34	58	47	66	70	41	43	56	2.6
H-GUR	-	-	-	-	55	65	73	52	75	80	122	8.3
H-HDA	-	-	-	-	31	5	34	12	14	-	74	6.7
H-IAY	27	31	36	37	28	37	34	30	35	25	25	-0.5
H-IBO	45	50	60	67	57	68	68	78	83	72	87	3.6
H-JNT	16	31	22	43	45	52	44	33	43	49	33	1.1
H-MCI	130	91	127	125	127	106	124	117	142	145	147	3.0
H-MFM	5	5	8	12	10	12	9	19	23	32	40	2.7
H-OHB	7	19	21	28	21	24	19	26	27	-	-	1.1
H-OTH	-	-	-	29	54	50	48	64	52	63	48	2.4
H-RIO	20	11	20	15	19	24	29	28	30	24	41	1.6
H-SBF	23	23	26	25	21	24	23	14	27	31	33	0.6
H-UP	-	-	-	-	43	42	39	63	66	68	79	6.7
H-XUB	5	40	43	42	45	42	56	63	61	78	68	5.0
A-AYE	11	28	11	45	28	51	30	55	42	20	90	3.5
A-BBP	33	27	10	53	17	20	15	17	15	5	11	-2.1
A-BC	26	68	-	70	79	72	42	79	40	-	-	-1.0
A-CCE	27	36	36	33	31	37	43	37	-	27	-	0.2
A-CMA	147	145	107	170	136	127	143	137	144	170	183	3.0
A-DHR	-	-	-	-	40	36	39	33	30	41	42	0.2
A-DHV	11	19	14	19	27	23	31	25	42	48	35	2.6
A-FHR	-	-	-	-	24	58	50	57	65	59	-	5.8
A-GBG	-	-	-	-	21	36	35	40	43	48	47	3.9
A-JST	-	-	-	41	41	40	47	68	63	54	53	2.8
A-MN	24	17	28	25	28	32	48	58	71	56	74	5.6
A-OAF	10	9	-	16	12	11	16	16	18	15	26	1.2
A-TLT	39	50	36	51	65	73	83	66	63	50	94	3.7
A-VN	-	-	-	17	30	48	33	37	45	54	45	3.7

1 regression of size of herd over years

Table 11. Values of t obtained for the four traits in males

Herd	Preweaning ADG	Conformation Score	Post-Weaning ADG	Weight-Per-Day Of Age
H-AAIN	-4.554	-1.360	2.358	-4.605
H-AET	0.449	4.894	0.822	1.053
H-ARJ	-0.093	1.880	-4.463	-2.681
H-ASL	-4.542	-0.980	0.018	-1.343
H-BBF	-2.271	3.971	-0.398	-2.443
H-BGN	-2.897	0.877	-3.373	-5.044
H-BKP	0.844	1.625	2.298	1.385
H-BSB	-2.459	0.725	0.616	0.024
H-BVZ	0.261	1.254	0.553	0.860
H-BZD	-1.088	3.393	-1.220	-3.981
H-DEE	1.780	-0.014	0.013	0.446
H-DSF	-0.059	-0.715	0.234	-0.101
H-ETU	-1.170	-0.899	0.963	-0.254
H-EZC	-0.461	-1.910	1.543	1.445
H-FSI	-1.239	-1.247	-1.537	-0.506
H-GDT	-1.375	0.354	2.267	-1.194
H-GUR	-0.086	0.194	1.787	3.092
H-HDA	-2.974	1.767	-0.270	-0.989
H-IAY	-3.213	5.927	3.337	0.094
H-IBO	1.051	3.430	-1.006	-0.634
H-JNT	-0.170	0.015	-4.838	-2.512
H-MCI	-0.734	1.567	1.342	-0.016
H-MFM	-0.790	0.399	1.436	0.472
H-OHB	-1.156	2.612	0.827	-0.500
H-OTH	-1.261	1.250	-1.371	-0.906
H-RIO	2.505	4.485	-0.839	0.569
H-SBF	3.136	3.279	-1.649	-0.746
H-UP	-2.521	1.617	-0.533	-1.276
H-XUB	-0.624	0.287	-0.224	-0.603
A-AYE	-1.303	-0.580	0.558	0.232
A-BBP	-0.253	4.201	-0.575	-1.278
A-BC	-2.168	0.075	0.254	-2.111
A-CCE	0.687	1.645	0.280	-1.092
A-CMA	1.444	-0.906	0.117	0.919
A-DHR	8.539	-1.396	-0.849	1.984
A-DHV	-0.847	0.164	2.090	0.342
A-FHR	0.287	-0.411	2.681	0.793
A-GBG	1.029	0.157	3.738	4.967
A-JST	0.568	2.815	1.257	2.299
A-MN	0.764	-1.173	2.564	0.842
A-OAF	0.514	7.559	1.218	0.754
A-TLT	2.185	1.120	1.156	1.005
A-VN	0.894	5.021	2.022	4.270

Table 12. Values of t obtained for the four traits in females

Herd	Preweaning ADG	Conformation Score	Post-Weaning ADG	Weight-Per-Day Of Age
H-AAIN	-5.063	-1.818	-0.272	-3.216
H-AET	-0.333	3.335	3.243	1.628
H-ARJ	0.132	0.740	0.106	-0.226
H-ASL	-3.180	-2.331	-0.940	-2.448
H-BBF	-1.996	2.817	-0.021	-1.213
H-BGN	-5.330	0.062	-0.933	-5.378
H-BKP	1.895	1.141	4.023	1.962
H-BSB	-2.334	-0.424	0.320	-2.637
H-BVZ	0.384	0.000	0.432	0.858
H-BZD	-1.322	1.791	-0.419	-4.657
H-DEE	1.385	-0.324	-1.396	-0.509
H-DSF	-1.180	3.984	3.207	1.097
H-ETU	-1.585	-0.267	-0.147	-1.612
H-EZC	-1.543	0.365	-0.762	1.209
H-FSI	0.016	-1.106	1.999	1.434
H-GDT	-0.821	1.781	1.639	0.196
H-GUR	-1.182	-0.448	2.422	3.378
H-HDA	-0.723	0.011	1.679	0.856
H-IAY	-2.265	0.750	3.438	0.041
H-IBO	0.652	2.204	0.182	0.654
H-JNT	0.551	6.842	-0.111	0.267
H-MCI	-0.972	3.427	4.592	0.967
H-MFM	-1.130	1.520	0.858	0.907
H-OHB	-1.195	1.000	1.592	-0.292
H-OTH	-1.249	0.008	0.023	-0.038
H-RIO	2.445	2.295	-0.548	-0.068
H-SBF	3.050	1.384	-1.715	-1.493
H-UP	-3.507	-0.015	1.149	0.513
H-XUB	-1.570	-0.498	1.090	-0.713
A-AYE	-0.583	-1.804	4.424	1.202
A-BBP	-3.606	1.605	-1.716	-2.537
A-BC	-0.081	-1.307	0.628	-1.257
A-CCE	5.130	2.753	1.861	2.867
A-CMA	1.593	0.114	0.066	1.095
A-DHR	2.715	-0.017	-0.920	1.487
A-DHV	1.243	0.065	1.161	0.763
A-FHR	-0.313	-0.906	1.643	-0.461
A-GBG	0.071	1.566	1.816	3.750
A-JST	0.178	-0.478	0.428	0.511
A-MN	0.816	-0.664	2.852	2.330
A-OAF	-1.391	4.962	1.423	0.021
A-TLT	1.948	1.272	-0.184	0.914
A-VN	-0.892	-0.628	5.920	3.105

Table 13. Values for analysis of variance of preweaning average daily gain in males

Herd	Degrees Of Freedom Due To		Mean Squares Due To		F
	Regression	Error	Regression	Error	
H-AAIN	1	3	7.320	0.353	20.738
H-AET	1	9	0.031	0.153	0.202
H-ARJ	1	9	0.003	0.374	0.009
H-ASL	1	4	8.036	0.390	20.627
H-BBF	1	9	1.298	0.252	5.158
H-BGN	1	7	1.123	0.134	8.393
H-BKP	1	9	0.444	0.623	0.712
H-BSB	1	5	1.988	0.329	6.046
H-BVZ	1	6	0.054	0.797	0.068
H-BZD	1	7	0.148	0.125	1.183
H-DEE	1	9	0.469	0.148	3.168
H-DSF	1	9	0.002	0.519	0.003
H-ETU	1	5	0.846	0.618	1.369
H-EZC	1	4	0.029	0.136	0.213
H-FSI	1	6	0.387	0.252	1.534
H-GDT	1	9	1.607	0.850	1.891
H-GUR	1	5	0.002	0.317	0.007
H-HDA	1	6	0.604	0.068	8.842
H-IAY	1	9	3.576	0.346	10.325
H-IBO	1	9	0.275	0.249	1.105
H-JNT	1	9	0.017	0.587	0.029
H-MCI	1	9	0.380	0.704	0.539
H-MFM	1	9	0.067	0.107	0.624
H-OHB	1	6	0.404	0.302	1.337
H-OTH	1	6	1.326	0.833	1.591
H-RIO	1	8	1.434	0.228	6.276
H-SBF	1	9	1.134	0.115	9.835
H-UP	1	6	4.276	0.673	6.354
H-XUB	1	9	0.393	1.008	0.390
A-AYE	1	8	0.735	0.433	1.698
A-BBP	1	9	0.006	0.087	0.064
A-BC	1	6	2.304	0.490	4.700
A-CCE	1	8	0.265	0.563	0.472
A-CMA	1	9	1.307	0.627	2.084
A-DHR	1	6	1.713	0.023	72.911
A-DHV	1	9	0.175	0.244	0.718
A-FHR	1	5	0.156	1.896	0.082
A-GBG	1	5	0.047	0.044	1.059
A-JST	1	5	0.072	0.223	0.323
A-MN	1	9	0.262	0.448	0.584
A-OAF	1	8	0.044	0.168	0.264
A-TLT	1	9	2.620	0.549	4.773
A-VN	1	7	0.438	0.548	0.799

Table 14. Values for analysis of variance of preweaning average daily gain in females

Herd	Degrees Of Freedom Due To		Mean Squares Due To		F
	Regression	Error	Regression	Error	
H-AAIN	1	3	2.465	0.096	25.635
H-AET	1	9	0.018	0.166	0.111
H-ARJ	1	7	0.014	0.822	0.018
H-ASL	1	4	2.441	0.241	10.113
H-BBF	1	9	0.673	0.169	3.984
H-BGN	1	7	1.904	0.067	28.408
H-BKP	1	9	0.892	0.248	3.592
H-BSB	1	5	1.209	0.222	5.446
H-BVZ	1	6	0.038	0.260	0.147
H-BZD	1	7	0.166	0.095	1.748
H-DEE	1	9	0.326	0.170	1.918
H-DSF	1	9	0.591	0.424	1.392
H-ETU	1	5	2.156	0.858	2.511
H-EZC	1	4	0.096	0.040	2.380
H-FSI	1	6	0.000	0.128	0.000
H-GDT	1	9	0.250	0.371	0.673
H-GUR	1	5	0.193	0.138	1.396
H-HDA	1	6	0.034	0.065	0.522
H-IAY	1	9	2.259	0.441	5.128
H-IBO	1	8	0.065	0.152	0.425
H-JNT	1	8	0.150	0.493	0.303
H-MCI	1	9	0.541	0.573	0.945
H-MFM	1	7	0.111	0.087	1.276
H-OHB	1	7	0.348	0.244	1.429
H-OTH	1	6	1.431	0.917	1.560
H-RIO	1	9	1.101	0.184	5.977
H-SBF	1	9	0.813	0.087	9.304
H-UP	1	6	2.889	0.235	12.301
H-XUB	1	8	2.233	0.906	2.465
A-AYE	1	8	0.094	0.277	0.340
A-BBP	1	8	4.539	0.349	13.004
A-BC	1	6	0.001	0.209	0.006
A-CCE	1	8	0.265	0.563	0.472
A-CMA	1	9	1.312	0.517	2.537
A-DHR	1	6	0.976	0.132	7.370
A-DHV	1	8	0.197	0.128	1.546
A-FHR	1	5	0.112	1.145	0.098
A-GBG	1	5	0.000	0.037	0.005
A-JST	1	6	0.013	0.414	0.032
A-MN	1	9	0.382	0.573	0.667
A-OAF	1	8	0.287	0.148	1.935
A-TLT	1	9	1.331	0.351	3.795
A-VN	1	7	0.207	0.260	0.795

Table 15. Values for analysis of variance of conformation score in males

Herd	Degrees Of Freedom Due To		Mean Squares Due To		F
	Regression	Error	Regression	Error	
H-AAIN	1	3	0.458	0.247	1.851
H-AET	1	6	5.028	0.210	23.951
H-ARJ	1	6	1.853	0.524	3.534
H-ASL	1	3	13.541	2.492	5.433
H-BBF	1	6	6.635	0.421	15.766
H-BGN	1	6	0.840	1.091	0.770
H-BKP	1	6	0.940	0.356	2.641
H-BSB	1	2	0.512	0.972	0.526
H-BVZ	1	3	3.003	1.909	1.573
H-BZD	1	6	5.581	0.485	11.515
H-DEE	1	6	0.000	0.461	0.000
H-DSF	1	6	0.145	0.284	0.511
G-ETU	1	3	0.150	0.186	0.809
H-EZC	1	2	0.313	0.086	3.649
H-FSI	1	3	1.036	0.666	1.556
H-GDT	1	6	0.098	0.780	0.126
H-GUR	1	1	0.009	0.237	0.038
H-HDA	1	4	0.242	0.078	3.121
H-IAY	1	6	6.947	0.198	35.134
H-IBO	1	6	15.751	1.339	11.766
H-JNT	1	6	0.000	0.414	0.000
H-MCI	1	6	2.654	1.080	2.456
H-MFM	1	6	0.117	0.732	0.160
H-OHB	1	5	3.086	0.452	6.822
H-OTH	1	3	1.422	0.910	1.562
H-RIO	1	5	15.780	0.785	20.112
H-SBF	1	5	4.915	0.457	10.755
H-UP	1	3	3.507	1.341	2.615
H-XUB	1	6	0.083	1.013	0.082
A-AYE	1	3	0.552	1.640	0.337
A-BBP	1	6	2.432	0.138	17.644
A-BC	1	6	0.016	2.773	0.006
A-CCE	1	7	3.968	1.467	2.705
A-CMA	1	5	0.364	0.443	0.822
A-DHR	1	3	1.249	0.641	1.948
A-DHV	1	6	0.034	1.252	0.027
A-FHR	1	3	0.288	1.710	0.169
A-GBG	1	2	0.026	1.067	0.025
A-JST	1	3	3.133	0.395	7.925
A-MN	1	6	0.172	0.125	1.375
A-OAF	1	5	5.909	0.103	57.143
A-TLT	1	6	1.346	1.072	1.255
A-VN	1	4	2.950	0.117	25.207

Table 16. Values for analysis of variance of conformation score in females

Herd	Degrees Of Freedom Due To		Mean Squares Due To		F
	Regression	Error	Regression	Error	
H-AAIN	1	3	1.670	0.505	3.306
H-AET	1	6	7.330	0.659	11.123
H-ARJ	1	4	0.349	0.637	0.548
H-ASL	1	3	13.541	2.492	5.433
H-BBF	1	6	4.904	0.618	7.937
H-BGN	1	6	0.001	0.212	0.004
H-BKP	1	5	1.486	1.142	1.302
H-BSB	1	4	0.174	0.972	0.179
H-BVZ	1	3	0.000	1.903	0.000
H-BZD	1	6	3.294	1.027	3.206
H-DEE	1	6	0.016	0.149	0.105
H-DSF	1	6	3.394	0.214	15.874
H-ETU	1	3	0.006	0.081	0.071
H-EZC	1	2	0.097	0.731	0.133
H-FSI	1	3	0.361	0.295	1.224
H-GDT	1	6	4.210	1.327	3.172
H-GUR	1	1	0.449	2.235	0.201
H-HDA	1	4	0.000	1.628	0.000
H-IAY	1	6	0.137	0.243	0.563
H-IBO	1	5	9.603	1.977	4.856
H-JNT	1	5	4.114	0.088	46.807
H-MCI	1	6	12.831	1.093	11.742
H-MFM	1	4	2.397	1.037	2.312
H-OHB	1	6	0.353	0.353	0.999
H-OTH	1	3	0.000	0.898	0.000
H-RIO	1	6	22.185	4.212	5.267
H-SBF	1	6	1.991	1.040	1.915
H-UP	1	3	0.000	1.918	0.000
H-XUB	1	5	0.184	0.745	0.248
A-AYE	1	5	3.589	1.103	3.253
A-BBP	1	6	1.496	0.580	2.578
A-BC	1	4	4.964	2.905	1.709
A-CCE	1	5	15.080	1.990	7.577
A-CMA	1	5	0.022	1.707	0.013
A-DUR	1	3	0.000	0.455	0.000
A-DHV	1	4	0.002	0.492	0.004
A-FHR	1	3	0.212	0.258	0.821
A-GBG	1	2	1.043	0.425	2.452
A-JST	1	4	1.232	5.396	0.228
A-MN	1	4	0.517	1.174	0.441
A-OAF	1	4	5.254	0.213	24.623
A-TLT	1	6	1.339	0.828	1.617
A-VN	1	2	0.690	1.750	0.394

Table 17. Values for analysis of variance of post-weaning average daily gain in males

Herd	Degrees Of Freedom Due To		Mean Squares Due To		F
	Regression	Error	Regression	Error	
H-AAIN	1	3	3.142	0.565	5.558
H-AET	1	9	0.054	0.080	0.676
H-ARJ	1	9	18.412	0.925	19.914
H-ASL	1	4	0.002	7.572	0.000
H-BBF	1	9	0.052	0.329	0.159
H-BGN	1	7	1.763	0.155	11.380
H-BKP	1	9	3.700	0.701	5.279
H-BSB	1	4	0.285	0.751	0.380
H-BVZ	1	6	0.304	0.992	0.306
H-BZD	1	7	0.508	0.341	1.489
H-DEE	1	9	0.000	0.557	0.000
H-DSF	1	9	0.049	0.886	0.055
H-ETU	1	5	1.111	1.198	0.928
H-EZC	1	4	0.697	0.293	2.381
H-FSI	1	6	1.116	0.472	2.362
H-GDT	1	9	1.875	0.365	5.138
H-GUR	1	5	28.368	8.879	3.195
H-HDA	1	6	0.006	0.080	0.073
H-IAY	1	9	13.682	1.228	11.138
H-IBO	1	9	0.839	0.829	1.012
H-JNT	1	9	8.744	0.374	23.404
H-MCI	1	9	3.122	1.734	1.800
H-MFM	1	9	0.817	0.396	2.061
H-OHB	1	6	0.917	1.342	0.683
H-OTH	1	6	5.265	2.801	1.879
H-RIO	1	8	0.236	0.336	0.703
H-SBF	1	7	0.751	0.276	2.720
H-UP	1	6	0.245	0.863	0.284
H-XUB	1	9	0.050	1.007	0.050
A-AYE	1	6	0.163	0.524	0.311
A-BBP	1	9	0.074	0.223	0.330
A-BC	1	6	0.047	0.720	0.065
A-CCE	1	8	0.040	0.509	0.078
A-CMA	1	8	0.034	2.494	0.014
A-DHR	1	6	0.359	0.498	0.720
A-DHV	1	9	1.203	0.275	4.369
A-FHR	1	5	3.371	0.469	7.189
A-GBG	1	5	1.388	0.099	13.974
A-JST	1	5	1.501	0.951	1.579
A-MN	1	9	3.332	0.507	6.574
A-OAF	1	8	0.516	0.348	1.482
A-TLT	1	9	0.324	0.242	1.337
A-VN	1	7	2.831	0.692	4.090

Table 18. Values for analysis of variance of post-weaning average daily gain in females

Herd	Degrees Of Freedom Due To		Mean Squares Due To		F
	Regression	Error	Regression	Error	
H-AAIN	1	3	0.094	1.272	0.074
H-AET	1	9	1.049	0.100	10.516
H-ARJ	1	7	0.040	3.549	0.011
H-ASL	1	4	3.072	3.478	0.883
H-BBF	1	9	0.000	0.274	0.000
H-BGN	1	7	0.219	0.252	0.870
H-BKP	1	9	11.097	0.686	16.183
H-BSB	1	5	0.074	0.719	0.102
H-BVZ	1	6	0.147	0.790	0.187
H-BZD	1	7	0.038	0.217	0.175
H-DEE	1	9	0.814	0.418	1.949
H-DSF	1	9	9.515	0.925	10.284
H-ETU	1	4	0.020	0.924	0.022
H-EZC	1	4	0.037	0.064	0.581
H-FSI	1	6	1.067	0.267	3.997
H-GDT	1	9	1.670	0.622	2.687
H-GUR	1	5	26.972	4.598	5.866
H-HDA	1	6	0.656	0.233	2.820
H-IAY	1	9	6.825	0.578	11.817
H-IBO	1	8	0.017	0.506	0.033
H-JNT	1	8	0.007	0.536	0.012
H-MCI	1	9	20.066	0.952	21.083
H-MFM	1	7	0.762	1.037	0.735
H-OHB	1	7	2.719	1.073	2.535
H-OTH	1	6	0.000	0.719	0.001
H-RIO	1	9	0.508	1.689	0.301
H-SBF	1	8	2.064	0.702	2.942
H-UP	1	6	2.435	1.844	1.320
H-XUB	1	8	0.945	0.796	1.188
A-AYE	1	8	3.468	0.177	19.573
A-BBP	1	8	5.677	1.928	2.945
A-BC	1	5	0.225	0.570	0.394
A-CCE	1	7	1.098	0.317	3.464
A-CMA	1	8	0.012	2.772	0.004
A-DHR	1	6	0.386	0.456	0.846
A-DHV	1	7	0.474	0.352	1.348
A-FHR	1	5	0.853	0.316	2.699
A-GBG	1	5	0.404	0.122	3.298
A-JST	1	6	0.434	2.367	0.183
A-MN	1	6	9.425	1.158	8.137
A-OAF	1	7	0.158	0.078	2.025
A-TLT	1	9	0.035	1.033	0.034
A-VN	1	3	8.756	0.250	35.045

Table 19. Values for analysis of variance of weight-per-day of age in males

Herd	Degrees Of Freedom Due To		Mean Squares Due To		F
	Regression	Error	Regression	Error	
H-AAIN	1	3	1.571	0.074	21.202
H-AET	1	9	0.200	0.180	1.108
H-ARJ	1	9	4.055	0.564	7.186
H-ASL	1	4	3.623	2.009	1.804
H-BBF	1	9	1.001	0.168	5.967
H-BGN	1	7	3.824	0.150	25.446
H-BKP	1	9	1.186	0.618	1.918
H-BSB	1	4	0.000	0.486	0.001
H-BVZ	1	6	0.602	0.815	0.739
H-BZD	1	7	0.985	0.062	15.849
H-DEE	1	9	0.097	0.489	0.199
H-DSF	1	9	0.007	0.717	0.010
H-ETU	1	5	0.027	0.417	0.065
H-EZC	1	4	0.558	0.267	2.088
H-FSI	1	6	0.179	0.701	0.256
H-GDT	1	9	0.916	0.642	1.427
H-GUR	1	5	12.204	1.277	9.560
H-HDA	1	6	0.216	0.221	0.978
H-IAY	1	9	0.003	0.362	0.009
H-IBO	1	9	0.335	0.835	0.402
H-JNT	1	9	3.087	0.489	6.310
H-MCI	1	9	0.000	1.539	0.000
H-MFM	1	9	0.048	0.215	0.222
H-OHB	1	6	0.188	0.753	0.250
H-OTH	1	6	1.568	1.910	0.821
H-RIO	1	8	0.127	0.392	0.323
H-SBF	1	7	0.061	0.109	0.557
H-UP	1	6	0.767	0.472	1.627
H-XUB	1	9	0.472	1.298	0.364
A-AYE	1	6	0.037	0.694	0.054
A-BBP	1	9	0.244	0.149	1.632
A-BC	1	6	2.206	0.495	4.455
A-CCE	1	8	0.355	0.298	1.192
A-CMA	1	8	0.178	0.211	0.845
A-DHR	1	6	1.126	0.286	3.936
A-DHV	1	9	0.030	0.256	0.117
A-FHR	1	5	0.538	0.856	0.629
A-GBG	1	5	2.045	0.083	24.666
A-JST	1	5	1.024	0.194	5.285
A-MN	1	9	0.463	0.652	0.710
A-OAF	1	8	0.131	0.231	0.568
A-TLT	1	9	0.277	0.274	1.011
A-VN	1	7	2.873	0.158	18.235

Table 20. Values for analysis of variance of weight-per-day of age in females

Herd	Degrees Of Freedom Due To		Mean Squares Due To		F
	Regression	Error	Regression	Error	
H-AAIN	1	3	2.064	0.200	10.344
H-AET	1	9	0.164	0.062	2.651
H-ARJ	1	7	0.027	0.528	0.051
H-ASL	1	4	10.014	1.672	5.990
H-BBF	1	9	0.198	0.135	1.472
H-BGN	1	7	3.044	0.105	28.927
H-BKP	1	9	2.713	0.705	3.848
H-BSB	1	5	1.098	0.158	6.956
H-BVZ	1	6	0.656	0.892	0.736
H-BZD	1	7	0.751	0.035	21.689
H-DEE	1	9	0.105	0.405	0.259
H-DSF	1	9	0.886	0.736	1.204
H-ETU	1	4	0.569	0.219	2.600
H-EZC	1	4	0.148	0.101	1.462
H-FSI	1	6	0.832	0.405	2.055
H-GDT	1	9	0.022	0.568	0.038
H-GUR	1	5	10.038	0.880	11.408
H-HDA	1	6	0.055	0.075	0.732
H-IAY	1	9	0.001	0.372	0.002
H-IBO	1	8	0.242	0.566	0.428
H-JNT	1	8	0.032	0.456	0.071
H-MCI	1	9	1.313	1.403	0.936
H-MFM	1	7	0.226	0.275	0.822
H-OHB	1	7	0.035	0.412	0.085
H-OTH	1	6	0.001	0.705	0.001
H-RIO	1	9	0.004	0.768	0.005
H-SBF	1	8	0.593	0.266	2.229
H-UP	1	6	0.193	0.733	0.263
H-XUB	1	8	0.369	0.726	0.508
A-AYE	1	8	0.674	0.467	1.445
A-BBP	1	8	6.742	1.048	6.435
A-BC	1	5	0.456	0.289	1.579
A-CCE	1	7	0.827	0.101	8.220
A-CMA	1	8	0.319	0.267	1.199
A-DHR	1	6	0.378	0.171	2.211
A-DHV	1	7	0.172	0.296	0.582
A-FHR	1	5	0.080	0.376	0.213
A-GBG	1	5	1.259	0.090	14.060
A-JST	1	6	0.426	1.633	0.261
A-MN	1	6	3.891	0.717	5.429
A-OAF	1	7	0.000	0.207	0.000
A-TLT	1	9	0.381	0.456	0.835
A-VN	1	3	1.718	0.178	9.139

Table 21. Evidence of effect of use of young performance tested sires on WDA in males

H-GUR 0.117*

63	OJ 19H -
	EPR 4P -
64	GUR 31S -
	OJ 19H -
	EPR 4P -
	EPR 6P -
	EPR 11R -
	GUR 9S -
65	EPR 6P -
	EPR 11R -
	EPR 4P -
	GUR 4P -
	GUR 9S -
66	GUR 21U (170 ^a ,2,110, ^b)
	EPR 6P -
	EPR 4P -
	EPR 11R -
67	EPR 4P -
	GUR 21U (170 ^a ,2,110, ^b)
	EPR 11R -
	HRM 15T -
68	HHR 3W -
	GUR 21U (170 ^a ,2,110, ^b)
	HRM 15T -
	GUR 40W (154,1,130,139) ^c
69	AAGU 3X (112,2,113,107) ^d
	GUR 40W (154,1,130,139)
	GUR 81X (146,__,99,126)
	GUR 21U (170 ^a ,2,110, ^b)

A-GBG 0.073*

63	GVZ 43S -
	CMA 65N -
	RVM 47P -
64	GBG 20T -
	GVZ 43S -
	RVM 47P -
65	DHV 13S (115,2,109,__)
	GVZ 43S -
	GBG 31U (124,1,111,__)
	GBG 44U (91,3,116,__)
66	RVM 47P -
	GBG 36U -
67	GBG 36U -
	OAF 6T (97,3,104,__)
	JPS 10V -
68	OAF 6T (97,3,104,__)
	FB 45U -
69	JTS 18X -
	UA 6T -

* not official

a preweaning ADG index

b conformation score

c post-weaning ADG index

d average daily lifetime index or WDA index

Table 21 Continued.....

A-VN 0.055*

61 MN 23L -
 62 VN 1M -
 VR 10R -
 63 VN 1M -
 VN 1R -
 64 RI 30K -
 65 RI 30K -
 66 RI 30K -
 MN 85U (98,2,92,97)
 67 MN 85U (98,2,92,97)
 VN 42S (140,_,_,_)
 VN 1U -
 VN 042U -
 68 MN 85U (98,2,92,97)
 69 MN 85U (98,2,92,97)

H-AET 0.019

59 5L -
 AET 6M -
 60 AET 6M -
 KIA 7N -
 61 LRE 5N -
 62 LRE 5N -
 63 LRE 5N -
 64 AON 28R -
 65 AON 28R -
 66 AON 28R -
 67 AON 28R -
 AON 23W -
 68 AON 23W -
 69 AON 23W -
 70 AON 23W -

Table 21 Continued.....

H-BKP 0.026

59 SCW 3G -

60 SCW 3G -
SCW 10N -

61 SCW 3G -
SCW 10N -
38N -

62 SCW 3G -
SCW 10N -
BKP 20R (95,2,110,_)

63 SCW 3G -
SCW 10N -
BKP 15S (112,3,89,_)

64 SCW 3G -
XUB 13S (119,1,110,_)

65 XUB 13S (119,1,110,_)
XUB 34T (107,3,98,_)

66 XUB 13S (119,1,110,_)
XUB 47U (115,_,103,112)

67 XUB 13S (119,1,110,_)
XUB 47U (115,_,103,112)

68 BKP 2X (131,_,121,123)
XUB 13S (119,1,110,_)

69 BKP 2X (131,_,121,123)
XDS 14Y -

H-BSB 0.001

59 BVU 13H -

60 BVU 13H -

61 UA 6M -
BVU 13H -

63 UA 6M -
BVU 13H -
EYI 6K -

64 EYI 6K -
SFE 25S -

65 SFE 25S -
EYI 6K -

66 BSB 1V -
SFE 25S -

67 AGF 80W -
SFE 25S -
BSB 1V -

68 AGF 80W -
SFE 25S -

Table 21 Continued.....

H-VVZ 0.030

62 29L -
MKA 3K -
7M -

63 MTZ 39M -
DJT 15R -
ENY 9M -

64 ENY 9M -
WAE 11P -

65 WAE 22T -
ENY 9M -
OJ 28T -
WAE 11P -

66 ENY 9M -
OJ 28T -
WAE 22T -
WAE 11P -

67 BVZ 2W (95,__,107,100)
ENY 9M -
OJ 28T -
WAE 22T -

68 HDA 77X (120,1,102,109)
WAE 11P -
OJ 28T -

69 AAGU 4R (104,1,97,_)
HDA 77X (120,1,102,109)
OJ 28T -

H-DEE 0.010

59 AOP 2E -

60 KKH 17M -
KKH 9N -

61 KKH 17M -

62 KKH 17M -

63 KKH 17M -

64 JS 6T -

65 JS 6T -

66 KKH 58U -
KKH 72U -

67 KKH 58U -

68 DEE 10X -
KKH 58U -

69 KKH 124X -
DEE 12X (103,3,115,109)

Table 21 Continued.....

H-ETU 0.033

61 AYD 15G -

62 RJU 89R -
AYD 15G -63 BHG 34R -
RJU 89R -64 RJU 89R -
BHG 34R -

65 MFM 7T (118,2,109,_)

66 MFM 7T (118,2,109,_)
RJU 89R -67 MFM 7T (118,2,109,_)
RJU 89R -68 RJU 89R -
788W -H-EZC 0.04663 JK 1R -
EVI 3P -64 JK 1R -
VY 40N -65 ATL 11H -
BUL 15T -
JK 1R -
VY 10L -66 JK 1R -
BUL 15T -
DJT 20U -67 BUL 15T -
DJT 20U -
JK 1R -68 EZC 23W (114,_,109,113)
JK 1R -
DJT 20U -

Table 2i Continued.....

H-HDA 0.021

- 61 HDA 4N -
AGF 7P -
HDA 34J -
- 62 HDA 15R -
PBV 78P -
HDA 72M -
HDA 23F -
- 63 HDA 23F -
HDA 72M -
PBV 57R -
- 64 PBV 57R -
HAJ 13R -
HDA 5S (113,1,112,_)
- 65 WAE 12S -
HDA 72M -
HDA 19U (93,3,104,_)
PBV 57R -
- 66 JBC 19V -
SCW 13T -
HDA 5S (113,1,112,_)
- 67 HDA 5S (113,1,112,_)
JBC 19V -
BKP 1V -
- 69 PBV 5W (119,_,107,107)
HDA 5S (113,1,112,_)
226 -

H-IAY 0.002

- 59 DJT 10K -
BRR 970M -
- 60 DJT 10K -
CDN 1N -
- 61 DJT 10K -
CDN 1N -
- 62 VSH 81N -
CDN 1N -
AGF 1R -
- 63 VSH 81N -
UGA 1N -
- 64 VSH 81N -
AGF 1R -
CDN 1N -
EYI 30S -
- 65 EYI 30S -
- 66 EYI 30S -
- 67 BYG 30U -
NEI 1W -
- 68 KKH 72V -
- 69 KKH 122X -

Table 21 Continued.....

H-MFM 0.007

59 ETB 3L -

60 ETB 3L -
RRV 2M -

61 EBT 3L -

62 WHRX 1P -

63 WHRX 1P -

64 DG 19R -
WHRX 1P -
MFM 18T -

65 RZV 22T -

67 RJU 591V -

68 RJU 591V -

69 RJU 591V -
MFM 2Y (112,_,97,107)H-RIO 0.01159 RIO 12J -
RIO 1M -60 RIO 17N -
RIO 12J -61 DBK 21N -
42N -

62 DBK 21N -

64 HDA 1T (108,_,_,_)
DBK 21N -65 JK 37R -
HDA 1T (108,_,_,_)
DBK 21N -

66 HDA 1T (108,_,_,_)

67 BBF 13W (130,_,118,123)
ALD 9W (115,_,_,_)68 BBF 13W (130,_,118,123)
ALD 9W (115,_,_,_)69 BBF 13W (130,_,118,123)
ALD 9W (115,_,_,_)

Table 21 Continued.....

<u>A-AYE 0.005</u>		<u>A-CMA 0.005</u>	
59	BC 66L -	59	CMA 138J - CMA 1K - EB 50J - CMA 2F - 5505 -
60	BC 66L -		
61	BC 66L -		
62	257 - BC 66L - BC 73N -	60	CMA 138J - CMA 128M - EB 50J - CMA 2F - CMA 1K - 5505 -
63	BC 66L - 257 - DMX 13P -		
64	BC 66L - GMH 6T - 931 - DMX 13P -	61	CMA 128M - CMA 2F - EB 50J -
65	931 - BC 66L - GMH 6T - BBK 19P - BC 24M - BC 44U (119,__,92,102) BC 64K -	62	EB 50J - CMA 128M -
66	BC 7U (95, __,104,95) BC 66L - VE 10U (121,2,119,_) 931 -	63	LBP 760 - CMA 138J - EB 50J - CMA 128M - CMA 2M - COL 19E -
67	BC 7U (95, __,104,95) BC 12V (110, __,108,109) BC 29V* VE 10U (121,2,119,_)	64	PGB 10S - CMA 2M - CMA 128M - CMA 735 (119,1,118,_) COL 19E - LBP 750 - CMA 138J -
68	AYE 2X (98, __,98,100) AYE 3V* AYE 24X (117, __,105,114) BC 29V*	65	CFC 5T - CMA 138T (112,1, __, __) LBP 760 - LMA 60S - CMA 73S (119,1,118,_) 1728 -
69	RB 35U - FHR 1Y (115, __, __, __) CU 35X -	66	1728 - CMA 73S (119,1,118, __) CMA 138T (112,1, __, __) LMA 60S - COL 19E - LBP 760 - 0842 - CFC 5T -

* test station

Table 21 Continued.....

A-CMA 0.005 Continued.....

- 67 CMA 138T (112,1,_,_)
 1728 -
 CMA 2V -
 CMA 73S (119,1,118,_)
 LBP 760 -
 APF 7L -
 LMA 60S -
- 68 CMA 167U -
 LBP 760 -
 2113 -
 0842 -
 1029
 1728 -
 CMA 138T (112,1,_,_)
 APF 7L -
- 69 8420 -
 CMA 138T (112,1,_,_)
 CMA 143W -
 CMA 154W (118,_,_,_)
 LBP 760 -

A-DHR 0.046

- 62 DHR 1P -
 BDY 31N -
- 63 DHR 1R -
 DHR 11R -
- 64 DHR 1R -
 DHR 15T (120,2,119,_)
- 65 DHR 1R -
 VN 3S (107,2,98,_)
- 66 DHR 27U (107,2,114,_)
 VN 3S (107,2,98,_)
- 67 DHR 27U (107,2,114,_)
 DHR 27V (119,3,110,_)
- 68 DHR 27U (107,2,114,_)
 DHR 25W (110,_,112,111)
- 69 DHR 10X (117,_,101,112)
 DHR 25W (110,_,112,111)

Table 21 Continued.....

A-DHV 0.005

59 DHV 2K -

60 DHV 4N -
YH 48J -

61 DHV 4N -

62 DHV 18R (110,1,101,_)
DHV 4N -

63 DHV 18R (110,1,101,_)
BBL 38S -
DHV 4N -
DHV 14R (107,2,101,_)

64 RBS 1T -
DHV 28T -
BBP 10M -

65 DHV 28T -
RBS 1T -
AXY 23M -

66 AXY 23M -
DHV 28T -
RBS 1T -

67 JSP 36V -
DHV 14W (106,_,106,105)
RBS 1T -
TJS 12V -
TJS 17W -

68 CKA 12W -
DHV 7X (110,_,114,108)
TJS 17W -

69 CKA 12W -
DHV 7X (110,_,114,108)
OAF 14X (107,_,105,105)

A-FHR 0.027

62 BDY 29J -
JJB 68P -
21 -

63 JJB 1R -
FHR 4S -
21 -

64 771 -
FHR 4S -
11K -
JPY 19P -

65 FHR 4S -
21 -
FHR 54U -
JJB 10U -

66 21 -
FHR 23U (98,2,108,_)
FHR 54U -
FHR 7V -
FHR 23V (112,1,102,_)

67 FHR 55V (93,_,107,99)
FHR 65V -
21 -

68 FHR 4S -
FHR 23W (120,_,104,115)
FHR 46W (114,_,105,104)
FHR 80X (148,_,115,132)

Table 21 Continued.....

A-JST 0.038

62 JST 25R -
CKA 17M -

63 CKA 17M -
JST 26S -
JST 23S -

64 JST 23S -
JST 26S -
RI 36T -

65 FKZ 13S -
JST 37T (122,2,138,_)
JST 17U (98,_,_,_)
JST 27S -

66 AUZ 42S -
CU 67U (119,_,116,116)

67 JST 37T (122,2,138,_)

68 158W -
MN 55W (110,_,116,114)
JST 29T (100,3,87,_)

69 JST 46W (111,_,124,119)
OAF 2U (112,_,107,107)
RB 2L -

A-MN 0.018

59 MN 2J -
MN 70L -

60 MN 2J -
MN 70L -

61 MN 2J -
MN 30P -

62 MN 2J -
MN 55P -

63 MN 2J -
MN 80S (108,2,134,_)
MN 90S (91,2,121,_)
MN 30R (101,1,98,_)

64 MN 2J -
OGC 1J -
MN 26T (94,1,116,_)

65 OGC 1J -
MN 2J -
MN 24T (107,2,107,_)
MN 6U (93,_,_,_)

66 OGC 1J -
BBL 154V -
MN 55V (112,1,116,_)
VN 94V (124,2,116,_)

67 BBL 156V -
EKC 15V -
MN 2J -
MN 55V (112,1,116,_)

68 JST 46W (111,_,124,119)
MN 55V (112,1,116,_)
RVM 213X -

69 JST 46W (111,_,124,119)

Table 21 Continued.....

A-OAF 0.016

60 JPY 5N -
 62 DHV 16P (104,1,114,_)
 63 DHV 16P (104,1,114,_)
 64 DHV 16P (104,1,114,_)
 65 OAF 2U (112,_,107,107)
 66 OAF 2U (112,_,107,107)
 67 OAF 2U (112,_,107,107)
 68 OAF 2U (112,_,107,107)
 69 CKA 2X (118,_,102,112)

A-TLT 0.011

59 TLT 19M -
 FF 45K -
 TLT 3L -
 TLT 2M -
 60 TLT 3L -
 TLT 19M -
 61 TLT 3L -
 TLT 19M -
 62 TLT 12P (94,2,_,_)
 TLT 19M -
 63 FF 60R (103,3,107,_)
 DGO 10S -
 TLT 51R (103,1,98,_)
 64 NA 34S -
 DGO 10S -
 FF 60R (103,3,107,_)
 65 DGO 10S -
 FF 60R (103,3,107,_)
 NA 34S -
 66 DGO 10S -
 NA 34S -
 TLT 12U (109,1,113,107)
 67 CKA 8R -
 TLT 12U (109,1,113,107)
 68 CKA 8R -
 TLT 12U (109,1,113,107)
 TLT 27X (93,3,101,95)
 69 TLT 1Y (102,_,120,111)
 TLT 7Y (133,_,109,120)
 TLT 12U (109,1,113,107)

Table 21 Continued.....

H-AAIN -0.100*

62 DGT 5K -
3L -

63 DGT 5K -
BHG 60S -

64 BHG 60S -
PPHR 65 -

65 239C
PPHR 65 -

66 239C
64 -

H-ARJ -0.043*

59 264-56 -

60 264-56

61 MTZ 2P -
264-56 -

62 MTZ 2P -
264-56 -
20A -

64 MTZ 2P -

65 ARJ 56U -
ARJ 57U -
MTZ 25U -
MTZ 2P -

66 ARJ 56U -
ARJ 57U -
JBC 3V -
MTZ 2P -

67 ARJ 56U -
ARJ 57U -
ARJ 93U -
JBC 3V -
MTZ 2P -
MTZ 11S -

68 ARJ 57U -
JBC 3V -
JBC 11S -
JBC 76X -
MTZ 2P -

69 ARJ 57U -
ARJ 93U -
JBC 3V -
JBC 76X -
MTZ 2P -

Table 21 Continued.....

H-BBF -0.033*

59 AKY 7L -
 60 AKY 7L -
 27N -
 61 AKH 8L -
 27N -
 BBF 6P -
 62 BBF 6P -
 63 BBF 6P -
 64 BBF 6P -
 65 BBF 6P -
 BBF 1U (128,1,96,116)
 66 BBF 1U (128,1,96,116)
 BBF 32V (121,1,105,112)
 67 BBF 1U (128,1,96,116)
 68 ALD 15X (__,2,__,99)
 TEM 25V -
 69 ALD 15X (__,2,__,99)
 TEM 25V -

H-BGN -0.084*

59 ANS 12M -
 BGN 14L -
 BGN 2J -
 60 ANS 12M -
 GBN 2J -
 61 ANS 12M -
 62 ANS 12M -
 BGN 6R -
 63 ANS 12M -
 AAN 77S (117,2,95,_)
 64 ANS 12M -
 AAN 77S (117,2,95,_)
 65 AAKW 1U (ii,2,120,107)
 ANS 12M -
 66 BGN 20U (96,2,87,100)
 ANS 12M -
 67 ANS 12M -
 UBR 3V (84,2,92,88)

Table 21 Continued.....

H-BZD -0.063*

59 BZD 25L -
LRD 52H -

60 BZD 25L -

61 BZD 25L -

62 JLB 10P -
DLK 1R -

63 DLK 1R -
JLB 10P -

64 JLB 10P -

65 JLB 10P -
TGB 32T -

66 TGB 32T -

67 ETB 28R -

H-JNT -0.048*

59 DDV 15M -
SBF 20J -

60 JN 018N -
SBF 20J -

61 JN 018N -
SBF 20J -

62 LRD 33R -

63 HC 18P -
LRD 33R -

64 HC 18P -
AGF 33R -

65 HC 18P -
AGF 33R -
TDG 13U -

66 HC 18P -
AGF 33R -
TDG 13U -

67 TDG 13U -

68 TDG 13U -
AGF 17W -

69 TDG 13U -
NMB 11Y -

Table 21 Continued.....

H-ASL -0.022

62 LFH 72M -
 2324D -
 168A -
 VV 853 -

63 LFH 72M -
 LFH 71R -
 225B -
 2324D -
 193A -

64 207 -
 193A -
 197C -
 LFH 71R -
 ASL 11T (107,2,88,_)

65 207 -
 18 -
 US 107C -
 ASL 11T (107,2,88,_)

66 US 107C -
 US 14,22,27 -
 ASL 45U (119,1,93,106)
 ASL 92V (102,2,123,110)

67 28T -
 113W -

H-DSF -0.002

59 ATL 2E -
 EPZ 5A -

60 ATL 2E -
 FT 12B -

61 ATL 2E -
 MCW 82F -

62 AGF 5K -
 MCW 82F -

63 AGF 5K -

64 AGF 5K -
 DSF 34R (95,3,94,_)
 DSF 40S (115,2,120,_)

65 AGF 5K -
 DSF 34R (95,3,94,_)
 DSF 40S (115,2,120,_)

66 AGF 5K -
 AGF 24S -
 DSF 40S (115,2,120,_)
 DSF 25U (115,1,125,_)

67 AFF 401V -

68 AAN 3W (117,1,127,126)
 AFF 401V -

69 AFF 12V -
 AAN 3W (117,1,127,126)
 AGF 5K -

Table 21 Continued.....

H-FSI -0.017

- 62 OJ 47J -
AKH 53N -
- 63 OJ 47J -
AKH 53N -
- 64 FSI 8T (103,1,103,_)
OJ 47J -
AKH 53N -
- 65 OVM 3N -
OJ 47J -
HAJ 28T -
- 66 OVM 3N -
OJ 47J -
HAJ 28T -
- 67 OJ 47J -
FSI 21V (112,2,104,113)
OJ 84V -
- 68 FSI 21V (122,2,104,113)
FSI 40W (_,2,125,123)
HAJ 28T -
- 69 FSI 41X (_,3,90,95)
FSI 40W (_,2,125,123)
DJT 18X -

H-GDT -0.027

- 59 KOD 21K -
CTY 2H -
- 60 GDT 3M -
CTY 2H -
- 61 GDT 14N -
CTY 2H -
- 62 DLK 16P -
- 63 AFF 20R -
DLK 16P
- 64 AFF 20R -
GDT 11S (107,1,125,_)
- 65 AFF 20R -
GDT 11s (107,1,125,_)
- 66 AFF 20R -
GDT 11S (107,1,125,_)
- 67 JVF 12V -
AFF 20R -
GDT 43V (122,1,109,117)
- 68 GDT 57W (134,2,116,127)
JVT 12V -
- 69 GDT 12Y (108,_,103,106)
GDT 57W (134,2,116,127)

Table 21 Continued.....

<u>H-IBO -0.010</u>		<u>H-MCI -0.000</u>	
59	MCI 108J - ZA 26L -	59	MCI 121F - IL 12K - MCI 129H - JHR 22L - HC 21L - RJM 18F - MCI 58K -
60	MCI 108J - ZA 26L -		
61	MCI 108J - ZA 26L -		
62	MCI 108J - EYI 30P - ZA 26L -	60	JHR 22L - MCI 121F - IL 12K -
63	MCI 108J - EYI 30P - KKH 46R -	61	MCI 22L - MCI 51N - MCI 121F - MCI 131M -
64	EYI 20S - EYI 30P - KKH 46R -	62	MCI 51N - MCI 95L - MCI 7P (114,2,147,_) MCI 34P (125,1,147,_)
65	EYI 20S - IBO 8U (104,1,107,104) EYI 30P -	63	MCI 51N - MCI 7P (114,2,147,_) MCI 34P (125,1,147,_) MCI 34R (112,2,96,_)
66	BLE 3S - JUX 43T - IBO 20U (114,1,120, 116) JSP 18E - GCI 18V -	64	MCI 51N - MCI 7P (114,2,147,_) MCI 34P (125,1,147,_) MCI 21S (118,1,122,_) MCI 111S (138,2,115,_)
67	GCI 18V - JUX 43T - RJU 199T - IBO 8U (104,1,107,104) JSP 18U -	65	MCI 7P (114,2,147,_) MCI 34R (112,2,96,_) MCI 17T (91,2,118,_) MCI 22T (101,1,121,_)
68	JSP 18U - GCI 18V - IBO 8U (104,1,107,104)	66	MCI 17T (91,2,118,_) MCI 22T (101,1,121,_) MCI 86T (86,3,116,_) MCI 17U (109,2,101,106) MCI 67U (105,1,99,105)
69	AAN 52X - GCI 18V - IBO 8U (104,1,107,104) JSP 18U - RJU 188T -	67	MCI 94S (112,2,103,_) MCI 17T (91,2,118,_) MCI 22T (101,1,121,_) PBV 86T (86,3,116,_) AFF 292U -

Table 21 Continued.....

H-MCI -0.000 Continued.....

- 68 MCI 74W (2.53)*
 MCI 17T (91,2,118,_)
 MCI 22T (101,1,121,_)
 MCI 69X (98,3,91,94)
 MCI 94S (112,2,103,_)
 HDA 1W (108,2,132,114)
 LFD 17U -
 AFF 309U -
- 69 MCI 74W (2.53)*
 MCI 17T (91,2,118,_)
 MCI 52W (2.67)*
 MCI 28X (120,2,107,111)
 MCI 52Y (99,_,128,112)
 AFF 309U -
 HDA 1W (108,_,132,114)
 LFD 17U -

H-OHB -0.024

- 59 USX 5J -
- 60 OOS 6M -
- 61 OOS 6M-
- 62 OOS 6M -
- 63 OOS 6M -
- 64 OOS 6M -
- 65 OOS 20T -
- 66 OOS 20T -
- 67 OOS 20T -

* unadj. preweaning ADG

Table 21 Continued.....

H-OTH -0.042

60 SCW 27L -
 61 BUL 19N -
 62 BUL 19N -
 63 BFK 33L -
 BUL 19N -
 64 ASL 3T (106,2,100,_)
 PBV 78P -
 DLK 238 -
 65 PBV 78P -
 AHL 5T -
 66 AHL 5T -
 PBV 78P -
 67 PBV 78P -
 ENB 13T -
 PBV 43W (96,_,112,105)
 68 PBV 43W (96,_,112,105)
 PBV 78P -
 NFE 8T -
 69 NFE 8T -
 PBV 43W (96,_,112,105)

H-SBF -0.009

59 VSH 19L -
 60 VSH 19L -
 STH 6N -
 61 DGK 39H -
 IBO 16P (108,3,97,_)
 62 47P -
 63 VSH 57R -
 HAS 22S -
 IBO 16P (108,3,97,_)
 64 UP 1G -
 PBV 67T (115,_,_,_)
 65 UP 1G -
 UTY 3U -
 66 VSH 13K -
 HDA 86U -
 67 HDA 86U -
 AON 18M -
 ZA 36N -
 68 ABKJ 2T -
 69 DSW 19X -
 BKP 2Y -

Table 21 Continued.....

<u>H-UP -0.008</u>		<u>H-XUB -0.015</u>	
62	UP 15M - AKD 1D - PFW 515 -	59	BNN 72G - SCW 38J -
63	AKD 1D - PFW 44 -	60	AGF 17K - OEJ 74M - JRS 33K - AGF 18M -
64	AKD 1D - PFW 44 - PFW 219 -	61	AGF 18M -
65	PFW 900 - PFW 219 - ADK 1D -	62	AGF 18M - XUB 13P (96,2,102,_)
66	PFW 900 - PFW 219 - UP 13V (119,_,115,119) UP 26V (106,T,119,118)	63	XUB 13P (06,2,102,_) AGF 18M - XUB 41R - XUB 13S (119,1,110,_)
67	PFW 219 - PFW 900 - UP 6W (123,_,129,129) UP 13V (119,_,115,119)	64	AAGU 1S (101,2,115,_) XUB 13P (96,2,102,_) AAGU 2T (93,2,120,_) DJT 28S -
68	UP 3W (90,_,92,95) UP 6W (123,_,129,129) UP 13V (119,_,115,119) PFW 219 -	65	XUB 13P (96,2,102,_) AAGU 1S (101,2,115,_) XUB 15U (91,1,89,87) XUB 16U (88,3,96,93) XUB 2U (104,1,79,96) DJT 28S -
69	XUB 4Y (,_,105,96) UP 6W (123,_,129,129) RW 644 -	66	AAGU 1S (101,2,115,_) WAE 12P - XUB 13P (96,2,102,_) XUB 13V (123,1,119,120) XUB 35V (92,2,97,96) XUB 45U (109,2,111,111) XUB 53U -
		67	XUB 35V (92,2,97,96) XUB 51W (92,_,125,104) BKP 29V (120,1,110,113) XUB 13V (123,1,119,120) XUB 26W (108,_,112,107) AAGU 1S (101,2,115,_)

Table 21 Continued.....

H-XUB -0.015 Continued.....

68 AAGU 1S (101,2,115,_)
 AAGU 4R (104,1,97,_)
 XUB 51W (92,_,125,104)
 XUB 20X (113,2,113,115)
 XUB 13V (123,1,119,120)
 XUB 35V (92,2,97,96)
 XUB 69W -
 510 -

69 BKP 29V (120,1,110,113)
 XUB 13V (123,1,119,120)
 XUB 35V (92,2,97,96)
 510 -

A-BBP -0.019

59 BBP 13M -

60 BBP 13M -
 CU 18J -

61 BBP 13M -

62 GVZ 5P -

63 GVZ 5P -

64 GVZ 5P -

65 GVZ 5P -

66 GVZ 5P -
 BBP 1V (89,3,105,97)

67 BBP 1V (89,3,105,97)
 FF 97V (105,2,77,96)

68 BBP 1V (89,3,105,97)

69 BBP 6Y (89,_,_,_)
 JSP 35X -

Table 21 Continued.....

A-BC -0.047

59	BC 64K -
	WCF 3K -
	BC 12L -
60	BC 64K -
	BC 12L -
	BC 24M -
61	BC 64K -
	BC 24M -
62	BC 24M -
	BIY 3P -
	BBK 19P -
	BC 73N -
63	BIY 3P -
	BBK 19P -
	BC 64K -
	BC 21R (109,1,112,_)
	BC 24M -
64	BBK 19P -
	BC 64K -
	BC 21R (109,1,112,_)
	BC 24M -
	BC 19P -
	771 -
65	771 -
	BBK 19P -
	BC 24M -
	BC 44U (119,1,92,102)
	BC 64K -
66	771 -
	RB 35U -
	VE 44U (113,2,114,_)
	BC 64K -
	931 -
67	RB 35U -
	AYE 3V -

A-CCE -0.014

59	AYA 7L -
60	VE 19J -
61	VE 19J -
62	VE 19J -
63	CKA 8R -
64	CKA 8R -
65	CKA 8R -
66	CKA 8R -
67	CUM 30V (109,1,113,112)
68	CUM 30V (109,1,113,112)

APPENDIX B

WEIGHTED REGRESSION ANALYSIS OF ALBERTA RCP BEEF CATTLE PROGRAM

DEFINITION OF TERMS

HERD = TATTOO LETTERS OF EACH HERD

SEX = SEX OF EACH YEAR GROUP

YEAR = YEAR IN WHICH THE ANIMALS WERE WEANED

WNUM = NUMBER OF ANIMALS WEANED

WAVE = ADG TO WEANING FOR EACH GROUP

AWAVE = ADJUSTED ADG TO WEANING FOR EACH GROUP

TNUM = NUMBER OF ANIMALS TYPE SCORED

TAVE = AVERAGE TYPE SCORE FOR EACH GROUP

FNUM = NUMBER OF ANIMALS ON FEED TEST

FAVE = ADG ON FEED TEST FOR EACH GROUP

SNUM = NUMBER OF ANIMALS ON WT/DAY OF AGE TEST

AWDA = AVERAGE WT/DAY OF AGE FOR EACH GROUP

WEAN = REGRESSION COEFFICIENT OF ADG TO WEANING ON YEARS

TYPE = REGRESSION COEFFICIENT OF FINAL TYPE SCORE ON YEARS

FEED = REGRESSION COEFFICIENT OF ADG ON FEED ON YEARS

WTAGE = REGRESSION COEFFICIENT OF FINAL WT/AGE ON YEARS

1. INTRODUCTION

The purpose of this study is to investigate the effect of the independent variable on the dependent variable.

2. LITERATURE REVIEW

Previous studies have shown that the independent variable has a significant effect on the dependent variable.

It is hypothesized that the independent variable will have a positive effect on the dependent variable.

The study will be conducted using a quantitative research design.

The data will be collected from a sample of participants.

The results of the study will be analyzed using statistical methods.

The findings of the study will be discussed in relation to the research objectives.

The study will contribute to the understanding of the relationship between the independent and dependent variables.

The study will also provide practical implications for the field of study.

The study will be limited by the sample size and the research design.

The study will be a cross-sectional study.

The study will be conducted in a controlled environment.

The study will be a quantitative study.

The study will be a descriptive study.

The study will be a correlational study.

The study will be a causal study.

The study will be a longitudinal study.



APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	TNUM	FAVE	SNUM	AWDA
AAIN	M	62	11	2.24	2.25	9	2.56	9	2.29	9	2.46
AAIN	M	63	15	2.15	2.20	14	2.86	14	2.25	14	2.18
AAIN	M	64	14	2.03	2.10	14	3.00	14	2.55	14	2.22
AAIN	M	65	27	1.54	1.65	22	2.86	22	2.89	22	2.06
AAIN	M	66	29	1.55	1.66	26	2.92	27	2.70	27	1.98
WEAN = -0.203			TYPE = -0.054			FEED = 0.141			WTAGE = -0.100		
AAIN	F	62	12	1.94	1.96	12	2.75	12	1.34	12	1.88
AAIN	F	63	15	1.75	1.81	15	2.60	15	1.21	15	1.54
AAIN	F	64	21	1.79	1.86	21	3.00	21	1.10	21	1.54
AAIN	F	65	22	1.53	1.58	22	3.14	22	1.58	22	1.55
AAIN	F	66	27	1.47	1.57	27	3.00	27	1.07	27	1.32
WEAN = -0.117			TYPE = -0.097			FEED = -0.023			WTAGE = -0.107		
AET	M	59	10	2.37	0.0	2	3.50	2	1.51	2	2.18
AET	M	60	6	2.36	0.0	3	3.00	3	1.92	3	2.36
AET	M	61	8	2.35	0.0	2	3.00	2	1.79	2	2.30
AET	M	62	9	2.55	0.0	5	3.00	5	1.69	5	2.36
AET	M	63	9	2.50	2.55	5	2.20	5	1.82	5	2.11
AET	M	64	9	2.31	2.36	7	2.43	7	1.69	7	2.01
AET	M	65	9	2.16	2.25	6	2.17	6	1.92	6	2.08
AET	M	66	7	2.31	2.42	6	2.17	6	1.70	6	2.05
AET	M	67	9	2.35	2.48	0	0.0	6	1.69	6	2.12
AET	M	68	10	2.39	0.0	0	0.0	10	1.72	10	2.30
AET	M	69	11	2.59	0.0	0	0.0	11	1.92	11	2.50
WEAN = 0.006			TYPE = 0.181			FEED = 0.010			WTAGE = 0.019		
AET	F	59	8	2.03	0.0	6	2.67	6	1.07	6	1.78
AET	F	60	6	2.12	0.0	3	3.00	3	1.28	3	1.93
AET	F	61	12	2.15	0.0	5	2.60	5	1.20	5	1.91
AET	F	62	9	2.15	0.0	5	3.00	5	1.17	5	1.90
AET	F	63	8	2.19	2.24	7	1.86	7	1.39	7	1.83
AET	F	64	10	1.78	1.84	4	1.75	4	1.16	4	1.67
AET	F	65	8	2.18	2.21	8	1.75	8	1.39	8	1.85
AET	F	66	12	2.18	2.27	7	1.86	7	1.12	7	1.77
AET	F	67	8	1.94	2.03	0	0.0	5	1.53	5	1.80
AET	F	68	15	2.04	0.0	0	0.0	10	1.54	10	2.00
AET	F	69	14	2.10	0.0	0	0.0	10	1.47	10	2.02
WEAN = -0.004			TYPE = 0.173			FEED = 0.038			WTAGE = 0.015		

Table 1. Summary of the data collected during the field study.

Sample No.	Date	Time	Location	Depth (m)	Temperature (°C)	Salinity (ppt)	pH	Dissolved Oxygen (mg/L)	Chlorophyll a (µg/L)	Chlorophyll b (µg/L)	Chlorophyll c (µg/L)	Chlorophyll d (µg/L)	Chlorophyll e (µg/L)	Chlorophyll f (µg/L)	Chlorophyll g (µg/L)	Chlorophyll h (µg/L)	Chlorophyll i (µg/L)	Chlorophyll j (µg/L)	Chlorophyll k (µg/L)	Chlorophyll l (µg/L)	Chlorophyll m (µg/L)	Chlorophyll n (µg/L)	Chlorophyll o (µg/L)	Chlorophyll p (µg/L)	Chlorophyll q (µg/L)	Chlorophyll r (µg/L)	Chlorophyll s (µg/L)	Chlorophyll t (µg/L)	Chlorophyll u (µg/L)	Chlorophyll v (µg/L)	Chlorophyll w (µg/L)	Chlorophyll x (µg/L)	Chlorophyll y (µg/L)	Chlorophyll z (µg/L)	
1	10/10/2010	08:00	Station 1	10	25.5	35.2	7.8	8.5	12.5	1.5	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	10/10/2010	09:00	Station 2	15	26.0	35.5	7.9	8.6	13.0	1.6	0.6	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
3	10/10/2010	10:00	Station 3	20	26.5	35.8	8.0	8.7	13.5	1.7	0.7	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4	10/10/2010	11:00	Station 4	25	27.0	36.0	8.1	8.8	14.0	1.8	0.8	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5	10/10/2010	12:00	Station 5	30	27.5	36.2	8.2	8.9	14.5	1.9	0.9	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6	10/10/2010	13:00	Station 6	35	28.0	36.5	8.3	9.0	15.0	2.0	1.0	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
7	10/10/2010	14:00	Station 7	40	28.5	36.8	8.4	9.1	15.5	2.1	1.1	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8	10/10/2010	15:00	Station 8	45	29.0	37.0	8.5	9.2	16.0	2.2	1.2	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
9	10/10/2010	16:00	Station 9	50	29.5	37.2	8.6	9.3	16.5	2.3	1.3	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
10	10/10/2010	17:00	Station 10	55	30.0	37.5	8.7	9.4	17.0	2.4	1.4	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
11	10/10/2010	18:00	Station 11	60	30.5	37.8	8.8	9.5	17.5	2.5	1.5	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
12	10/10/2010	19:00	Station 12	65	31.0	38.0	8.9	9.6	18.0	2.6	1.6	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
13	10/10/2010	20:00	Station 13	70	31.5	38.2	9.0	9.7	18.5	2.7	1.7	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
14	10/10/2010	21:00	Station 14	75	32.0	38.5	9.1	9.8	19.0	2.8	1.8	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
15	10/10/2010	22:00	Station 15	80	32.5	38.8	9.2	9.9	19.5	2.9	1.9	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
16	10/10/2010	23:00	Station 16	85	33.0	39.0	9.3	10.0	20.0	3.0	2.0	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
17	10/10/2010	00:00	Station 17	90	33.5	39.2	9.4	10.1	20.5	3.1	2.1	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
18	10/10/2010	01:00	Station 18	95	34.0	39.5	9.5	10.2	21.0	3.2	2.2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1
19	10/10/2010	02:00	Station 19	100	34.5	39.8	9.6	10.3	21.5	3.3	2.3	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1
20	10/10/2010	03:00	Station 20	105	35.0	40.0	9.7	10.4	22.0	3.4	2.4	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1
21	10/10/2010	04:00	Station 21	110	35.5	40.2	9.8	10.5	22.5	3.5	2.5	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1
22	10/10/2010	05:00	Station 22	115	36.0	40.5	9.9	10.6	23.0	3.6	2.6	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1
23	10/10/2010	06:00	Station 23	120	36.5	40.8	10.0	10.7	23.5	3.7	2.7	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
24	10/10/2010	07:00	Station 24	125	37.0	41.0	10.1	10.8	24.0	3.8	2.8	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2
25	10/10/2010	08:00	Station 25	130	37.5	41.2	10.2	10.9	24.5	3.9	2.9	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3
26	10/10/2010	09:00	Station 26	135	38.0	41.5	10.3	11.0	25.0	4.0	3.0	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4
27	10/10/2010	10:00	Station 27	140	38.5	41.8	10.4	11.1	25.5	4.1	3.1	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5
28	10/10/2010	11:00	Station 28	145	39.0	42.0	10.5	11.2	26.0	4.2	3.2	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6
29	10/10/2010	12:00	Station 29	150	39.5	42.2	10.6	11.3	26.5	4.3	3.3	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.7
30	10/10/2010	13:00	Station 30	155	40.0	42.5	10.7	11.4	27.0	4.4	3.4	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8
31	10/10/2010	14:00	Station 31	160	40.5	42.8	10.8	11.5	27.5	4.5	3.5	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9
32	10/10/2010	15:00	Station 32	165	41.0	43.0	10.9	11.6	28.0	4.6	3.6	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0
33	10/10/2010	16:00	Station 33	170	41.5	43.2	11.0	11.7	28.5	4.7	3.7	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1
34	10/10/2010	17:00	Station 34	175	42.0	43.5	11.1	11.8	29.0	4.8	3.8	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2
35	10/10/2010	18:00	Station 35	180	42.5	43.8	11.2	11.9	29.5	4.9	3.9	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3
36	10/10/2010	19:00	Station 36	185	43.0	44.0	11.3	12.0	30.0	5.0	4.0	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4
37	10/10/2010	20:00	Station 37	190	43.5	44.2	11.4	12.1	30.5	5.1	4.1	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5
38	10/10/2010	21:00	Station 38	195	44.0	44.5	11.5	12.2	31.0	5.2	4.2	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6
39	10/10/2010	22:00	Station 39	200	44.5	44.8	11.6	12.3	31.5	5.3	4.3	4.0	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6									

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
ARJ	M	59	8	1.77	0.0	8	3.00	8	2.51	8	2.30
ARJ	M	60	8	1.92	0.0	6	3.33	6	2.51	6	2.39
ARJ	M	61	14	1.87	0.0	14	2.57	14	2.27	14	2.25
ARJ	M	62	23	1.91	0.0	21	2.71	21	1.88	21	2.10
ARJ	M	63	20	2.00	2.01	18	2.50	18	1.88	18	2.15
ARJ	M	64	2	1.86	2.00	2	3.00	2	2.28	2	2.08
ARJ	M	65	37	1.86	1.95	35	2.60	35	1.66	35	1.77
ARJ	M	66	36	1.89	1.94	36	2.56	36	1.99	36	1.93
ARJ	M	67	59	1.80	1.86	0	0.0	48	1.73	48	1.80
ARJ	M	68	49	1.71	0.0	0	0.0	48	1.33	48	1.74
ARJ	M	69	52	2.03	0.0	0	0.0	48	1.51	48	2.01
WEAN = -0.001			TYPE = 0.052		FEED = -0.092		WTAGE = -0.043				
ARJ	F	60	15	1.62	0.0	15	2.73	15	0.83	15	1.45
ARJ	F	61	27	1.64	0.0	27	2.81	27	0.77	27	1.44
ARJ	F	62	20	1.79	0.0	19	2.63	19	0.82	19	1.54
ARJ	F	63	23	1.69	0.0	23	2.35	23	0.56	23	1.37
ARJ	F	65	46	1.59	1.66	45	2.62	45	0.67	45	1.15
ARJ	F	66	58	1.62	1.68	57	2.61	57	1.30	57	1.47
ARJ	F	67	62	1.48	1.54	0	0.0	58	1.15	58	1.34
ARJ	F	68	50	1.54	0.0	0	0.0	49	0.76	49	1.38
ARJ	F	69	50	1.89	0.0	0	0.0	50	0.56	50	1.44
WEAN = 0.002			TYPE = 0.020		FEED = 0.004		WTAGE = -0.003				
ASL	M	62	29	1.84	0.0	24	2.67	24	1.79	24	2.02
ASL	M	63	40	1.77	1.84	28	2.18	28	1.82	28	1.78
ASL	M	64	69	1.73	1.83	63	3.00	63	0.94	63	1.35
ASL	M	65	54	1.42	1.51	50	2.86	50	1.27	50	1.34
ASL	M	66	66	1.36	1.42	56	2.88	56	1.73	56	1.54
ASL	M	67	1	1.93	1.93	0	0.0	1	2.61	1	2.17
WEAN = -0.133			TYPE = -0.097		FEED = 0.003		WTAGE = -0.099				
ASL	F	62	34	1.52	0.0	33	2.67	33	0.74	33	1.58
ASL	F	63	45	1.60	1.67	44	2.25	44	0.50	44	1.11
ASL	F	64	38	1.53	1.63	38	2.82	38	0.45	38	1.03
ASL	F	65	69	1.34	1.43	64	2.98	64	0.19	64	0.83
ASL	F	66	83	1.33	1.41	80	3.05	81	0.29	81	0.85
ASL	F	67	4	1.43	1.44	0	0.0	4	1.89	4	1.59
WEAN = -0.066			TYPE = -0.163		FEED = -0.076		WTAGE = -0.136				

Table 1. Summary of the results of the analysis of variance for the effect of the treatment on the growth of the fish.

Source of variation: Replicate, Treatment, Error, Total, D.F., S.S., M.S., F-value, P-value, L.S.D.

Replicate	3	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Treatment	4	1.120	4	0.280	0.280	0.280	0.280	0.280	0.280	0.280
Error	4	0.000	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	11	1.120	8	0.280	0.280	0.280	0.280	0.280	0.280	0.280
D.F.	11	0.000	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F-value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P-value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L.S.D.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Replicate	3	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Treatment	4	1.120	4	0.280	0.280	0.280	0.280	0.280	0.280	0.280
Error	4	0.000	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	11	1.120	8	0.280	0.280	0.280	0.280	0.280	0.280	0.280
D.F.	11	0.000	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F-value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P-value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L.S.D.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Replicate	3	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Treatment	4	1.120	4	0.280	0.280	0.280	0.280	0.280	0.280	0.280
Error	4	0.000	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	11	1.120	8	0.280	0.280	0.280	0.280	0.280	0.280	0.280
D.F.	11	0.000	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F-value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P-value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L.S.D.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Replicate	3	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Treatment	4	1.120	4	0.280	0.280	0.280	0.280	0.280	0.280	0.280
Error	4	0.000	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	11	1.120	8	0.280	0.280	0.280	0.280	0.280	0.280	0.280
D.F.	11	0.000	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
S.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F-value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P-value	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L.S.D.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
BBF	M	59	7	2.56	0.0	6	2.67	6	2.15	6	2.58
BBF	M	60	8	2.33	0.0	5	2.40	5	1.59	5	2.20
BBF	M	61	9	2.42	0.0	10	2.50	10	2.08	10	2.47
BBF	M	62	8	2.43	0.0	8	2.63	8	2.09	8	2.48
BBF	M	63	12	2.43	2.55	11	1.91	11	2.17	11	2.36
BBF	M	64	13	2.33	2.42	10	2.10	13	2.15	13	2.25
BBF	M	65	17	2.44	2.55	7	1.57	17	1.78	17	2.14
BBF	M	66	17	2.12	2.26	11	1.82	17	2.10	17	2.11
BBF	M	67	16	2.30	2.40	0	0.0	16	1.91	16	2.13
BBF	M	68	15	2.46	0.0	0	0.0	5	1.83	5	2.39
BBF	M	69	22	2.05	0.0	0	0.0	12	2.06	12	2.25
WEAN = -0.032			TYPE = 0.143			FEED = -0.007			WTAGE = -0.033		
BBF	F	59	6	2.11	0.0	5	2.40	5	1.59	5	2.06
BBF	F	60	8	1.91	0.0	7	2.71	7	1.54	7	1.93
BBF	F	61	9	2.08	0.0	8	2.13	8	1.58	8	2.04
BBF	F	62	9	2.01	0.0	9	2.22	9	1.56	9	1.99
BBF	F	63	10	2.29	2.34	10	2.30	10	1.86	10	2.09
BBF	F	64	18	1.97	2.08	18	2.22	18	1.59	18	1.80
BBF	F	65	14	1.95	2.07	14	2.14	14	1.65	14	1.81
BBF	F	66	15	1.87	1.97	15	1.53	15	1.79	15	1.84
BBF	F	67	18	1.90	2.01	0	0.0	18	1.63	18	1.78
BBF	F	68	20	2.01	0.0	0	0.0	17	1.36	17	1.94
BBF	F	69	19	1.79	0.0	0	0.0	19	1.72	19	1.94
WEAN = -0.023			TYPE = 0.113			FEED = -0.000			WTAGE = -0.013		
BGN	M	59	7	2.11	0.0	6	2.83	6	2.12	6	2.32
BGN	M	60	10	2.24	0.0	10	2.70	10	2.19	10	2.42
BGN	M	61	10	2.35	0.0	10	2.50	10	2.04	10	2.41
BGN	M	62	11	2.11	0.0	11	1.82	11	2.25	11	2.37
BGN	M	63	17	2.16	2.27	17	2.35	17	1.84	17	2.01
BGN	M	64	7	1.99	2.04	7	2.00	7	2.05	7	2.02
BGN	M	65	6	1.77	1.81	6	2.67	6	1.80	6	1.78
BGN	M	66	9	1.95	2.04	8	2.38	8	1.86	8	1.91
BGN	M	67	13	1.96	2.04	0	0.0	13	1.73	13	1.85
WEAN = -0.044			TYPE = 0.052			FEED = -0.057			WTAGE = -0.084		
BGN	F	59	7	1.97	0.0	7	2.71	7	1.48	7	1.95
BGN	F	60	13	1.99	0.0	13	2.38	13	1.55	13	1.98
BGN	F	61	11	2.08	0.0	11	2.36	11	1.15	11	1.85
BGN	F	62	16	1.85	0.0	16	2.31	16	1.30	16	1.79
BGN	F	63	11	1.83	1.92	11	2.45	11	1.25	11	1.56
BGN	F	64	8	1.68	1.69	8	2.25	8	1.37	8	1.55
BGN	F	65	7	1.65	1.66	7	2.43	7	1.08	7	1.42
BGN	F	66	13	1.60	1.68	13	2.54	13	1.23	13	1.43
BGN	F	67	7	1.69	1.79	0	0.0	7	1.50	7	1.61
WEAN = -0.059			TYPE = 0.001			FEED = -0.020			WTAGE = -0.074		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
BKP	M	59	10	2.16	0.0	9	2.78	9	1.99	9	2.28
BKP	M	60	9	2.23	0.0	9	2.56	9	2.22	9	2.43
BKP	M	61	18	1.86	0.0	17	2.71	17	1.87	17	2.07
BKP	M	62	15	2.01	0.0	14	2.57	14	2.01	14	2.21
BKP	M	63	21	2.05	2.12	17	2.35	17	1.99	17	1.99
BKP	M	64	21	2.15	2.20	21	2.29	21	2.13	21	2.14
BKP	M	65	29	1.89	1.98	24	2.50	24	2.23	24	2.07
BKP	M	66	32	1.86	1.95	4	2.75	26	2.26	26	2.07
BKP	M	67	26	1.94	2.04	0	0.0	18	2.51	18	2.20
BKP	M	68	31	2.21	0.0	0	0.0	25	2.61	25	2.57
BKP	M	69	28	2.30	0.0	0	0.0	24	2.07	24	2.39
WEAN = 0.015			TYPE = 0.046			FEED = 0.046			WTAGE = 0.026		
BKP	F	59	13	1.91	0.0	12	2.92	12	1.11	12	1.74
BKP	F	60	19	1.95	0.0	18	2.61	18	1.02	18	1.72
BKP	F	61	22	1.80	0.0	16	2.69	16	1.10	16	1.67
BKP	F	62	30	1.69	0.0	30	2.77	30	1.22	30	1.67
BKP	F	63	20	1.85	1.90	20	2.50	20	0.97	20	1.45
BKP	F	64	24	1.88	1.94	19	2.10	19	1.12	19	1.57
BKP	F	65	28	1.76	1.85	28	2.68	28	1.16	28	1.50
BKP	F	66	26	1.82	1.91	0	0.0	23	1.53	23	1.67
BKP	F	67	46	1.91	1.98	0	0.0	37	1.54	37	1.74
BKP	F	68	24	2.01	0.0	0	0.0	23	1.85	23	2.12
BKP	F	69	42	2.02	0.0	0	0.0	32	1.49	32	1.97
WEAN = 0.018			TYPE = 0.053			FEED = 0.068			WTAGE = 0.034		
BSB	M	59	2	2.73	0.0	2	3.50	2	1.88	2	2.55
BSB	M	60	6	2.48	0.0	0	0.0	0	0.0	0	0.0
BSB	M	64	19	2.07	2.16	11	2.45	11	1.61	11	1.83
BSB	M	65	14	1.78	1.88	12	2.92	12	1.67	12	1.72
BSB	M	66	6	2.09	2.19	6	2.67	6	1.32	6	1.74
BSB	M	67	16	1.85	1.95	0	0.0	12	2.14	12	1.98
BSB	M	68	11	2.01	0.0	0	0.0	11	1.78	11	2.10
WEAN = -0.070			TYPE = 0.080			FEED = 0.037			WTAGE = 0.001		
BSB	F	59	4	2.08	0.0	4	3.00	4	1.45	4	1.98
BSB	F	61	8	1.79	0.0	8	2.13	8	1.42	8	1.81
BSB	F	62	12	1.84	0.0	11	2.01	11	1.26	11	1.77
BSB	F	63	25	1.96	2.02	25	2.36	25	1.22	25	1.64
BSB	F	65	12	1.57	1.64	12	2.42	12	1.27	12	1.44
BSB	F	66	12	1.80	1.86	12	2.58	12	0.95	12	1.43
BSB	F	67	19	1.61	1.70	0	0.0	19	1.61	19	1.61
WEAN = -0.050			TYPE = -0.026			FEED = 0.012			WTAGE = -0.048		

TABLE 1. Summary of the results of the analysis of variance for the effect of the different factors on the yield of the different components of the plant.									
Factor	Level	Yield (g)	Standard Error	Mean Square	Degrees of Freedom	F-value	Significance	Least Squares	Adjusted R-squared
Factor 1	Level 1	10.5	0.5	11.0	1	1.1	0.30	10.5	0.98
Factor 1	Level 2	11.0	0.5	12.1	1	1.2	0.28	11.0	0.98
Factor 1	Level 3	11.5	0.5	13.2	1	1.3	0.26	11.5	0.98
Factor 1	Level 4	12.0	0.5	14.3	1	1.4	0.24	12.0	0.98
Factor 1	Level 5	12.5	0.5	15.4	1	1.5	0.22	12.5	0.98
Factor 1	Level 6	13.0	0.5	16.5	1	1.6	0.20	13.0	0.98
Factor 1	Level 7	13.5	0.5	17.6	1	1.7	0.18	13.5	0.98
Factor 1	Level 8	14.0	0.5	18.7	1	1.8	0.16	14.0	0.98
Factor 1	Level 9	14.5	0.5	19.8	1	1.9	0.14	14.5	0.98
Factor 1	Level 10	15.0	0.5	20.9	1	2.0	0.12	15.0	0.98
Factor 2	Level 1	15.5	0.5	22.0	1	2.1	0.10	15.5	0.98
Factor 2	Level 2	16.0	0.5	23.1	1	2.2	0.08	16.0	0.98
Factor 2	Level 3	16.5	0.5	24.2	1	2.3	0.06	16.5	0.98
Factor 2	Level 4	17.0	0.5	25.3	1	2.4	0.04	17.0	0.98
Factor 2	Level 5	17.5	0.5	26.4	1	2.5	0.02	17.5	0.98
Factor 2	Level 6	18.0	0.5	27.5	1	2.6	0.01	18.0	0.98
Factor 2	Level 7	18.5	0.5	28.6	1	2.7	0.00	18.5	0.98
Factor 2	Level 8	19.0	0.5	29.7	1	2.8	0.00	19.0	0.98
Factor 2	Level 9	19.5	0.5	30.8	1	2.9	0.00	19.5	0.98
Factor 2	Level 10	20.0	0.5	31.9	1	3.0	0.00	20.0	0.98
Factor 3	Level 1	20.5	0.5	33.0	1	3.1	0.00	20.5	0.98
Factor 3	Level 2	21.0	0.5	34.1	1	3.2	0.00	21.0	0.98
Factor 3	Level 3	21.5	0.5	35.2	1	3.3	0.00	21.5	0.98
Factor 3	Level 4	22.0	0.5	36.3	1	3.4	0.00	22.0	0.98
Factor 3	Level 5	22.5	0.5	37.4	1	3.5	0.00	22.5	0.98
Factor 3	Level 6	23.0	0.5	38.5	1	3.6	0.00	23.0	0.98
Factor 3	Level 7	23.5	0.5	39.6	1	3.7	0.00	23.5	0.98
Factor 3	Level 8	24.0	0.5	40.7	1	3.8	0.00	24.0	0.98
Factor 3	Level 9	24.5	0.5	41.8	1	3.9	0.00	24.5	0.98
Factor 3	Level 10	25.0	0.5	42.9	1	4.0	0.00	25.0	0.98



APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
BVZ	M	62	16	2.13	0.0	12	2.25	12	2.04	12	2.33
BVZ	M	63	30	2.16	2.21	16	2.56	23	1.53	23	1.88
BVZ	M	64	24	2.10	2.18	18	2.78	22	1.54	22	1.82
BVZ	M	65	24	2.07	2.12	18	2.17	18	1.74	18	1.95
BVZ	M	66	32	1.93	1.99	20	1.90	20	1.65	20	1.88
BVZ	M	67	26	1.83	1.95	0	0.0	15	1.74	15	1.87
BVZ	M	68	32	2.13	0.0	0	0.0	21	2.09	21	2.32
BVZ	M	69	23	2.39	0.0	0	0.0	12	1.52	12	2.19
WEAN = 0.007			TYPE = 0.138			FEED = 0.021			WTAGE = 0.030		
BVZ	F	62	24	1.82	0.0	22	2.23	22	1.55	22	1.88
BVZ	F	63	32	1.92	2.01	31	2.87	32	1.20	32	1.58
BVZ	F	64	37	1.85	1.89	35	2.60	35	1.18	35	1.55
BVZ	F	65	33	1.82	1.89	33	2.51	33	1.18	33	1.52
BVZ	F	66	26	1.73	1.81	21	2.48	21	1.05	21	1.45
BVZ	F	67	26	1.72	1.77	0	0.0	23	1.41	23	1.59
BVZ	F	68	27	1.89	0.0	0	0.0	25	1.46	25	1.90
BVZ	F	69	27	1.99	0.0	0	0.0	24	1.36	24	1.88
WEAN = 0.006			TYPE = 0.000			FEED = 0.012			WTAGE = 0.025		
BZD	M	59	6	2.03	0.0	5	3.60	5	2.02	5	2.23
BZD	M	60	6	2.01	0.0	3	3.00	3	2.17	3	2.28
BZD	M	61	9	2.25	0.0	3	3.00	3	1.80	3	2.25
BZD	M	62	11	2.21	0.0	4	3.25	4	1.95	4	2.29
BZD	M	63	5	2.21	2.32	3	2.67	3	2.10	3	2.12
BZD	M	64	7	2.14	2.24	1	3.00	1	1.49	1	1.90
BZD	M	65	7	1.97	2.04	6	2.83	6	2.31	6	2.10
BZD	M	66	5	1.81	1.96	4	1.75	4	1.61	4	1.71
BZD	M	67	4	2.06	2.09	0	0.0	4	1.41	4	1.78
WEAN = -0.021			TYPE = 0.177			FEED = -0.045			WTAGE = -0.063		
BZD	F	59	5	1.91	0.0	5	3.00	5	1.37	5	1.85
BZD	F	60	8	1.87	0.0	8	2.88	8	1.47	8	1.88
BZD	F	61	8	1.97	0.0	8	2.88	8	1.24	8	1.83
BZD	F	62	11	2.00	0.0	11	3.09	11	1.22	11	1.84
BZD	F	63	7	2.07	2.09	6	1.83	6	1.41	6	1.78
BZD	F	64	10	1.86	1.92	10	2.60	10	1.43	10	1.66
BZD	F	65	10	1.75	1.79	7	2.14	7	1.52	7	1.66
BZD	F	66	1	1.42	1.51	1	3.00	1	1.02	1	1.25
BZD	F	67	2	1.85	1.90	0	0.0	2	0.73	2	1.38
WEAN = -0.025			TYPE = 0.126			FEED = -0.012			WTAGE = -0.055		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
DEE	M	59	4	2.07	0.0	4	2.75	4	2.07	4	2.27
DEE	M	60	9	1.98	0.0	9	2.89	9	2.11	9	2.24
DEE	M	61	7	2.07	0.0	7	2.57	7	2.11	7	2.29
DEE	M	62	7	1.96	0.0	7	2.86	7	1.97	7	2.17
DEE	M	63	6	1.92	1.94	5	2.80	5	1.90	5	1.92
DEE	M	64	9	1.94	2.02	8	2.25	8	2.05	8	1.98
DEE	M	65	19	1.86	1.94	10	2.90	10	1.57	10	1.77
DEE	M	66	28	2.09	2.16	20	2.80	20	1.77	20	1.95
DEE	M	67	7	2.05	2.15	0	0.0	7	1.80	7	1.96
DEE	M	68	15	2.27	0.0	0	0.0	13	1.83	13	2.29
DEE	M	69	21	2.11	0.0	0	0.0	21	2.26	21	2.37
WEAN = 0.021			TYPE = -0.000			FEED = 0.000			WTAGE = 0.010		
DEE	F	59	4	1.79	0.0	4	2.50	4	1.41	4	1.81
DEE	F	60	14	1.81	0.0	14	2.57	14	1.67	14	1.93
DEE	F	61	12	1.85	0.0	12	2.67	12	1.28	12	1.78
DEE	F	62	13	1.86	0.0	13	2.54	13	1.58	13	1.92
DEE	F	63	13	1.72	1.75	13	2.85	13	1.51	13	1.62
DEE	F	64	15	1.70	1.77	15	2.60	15	1.48	15	1.60
DEE	F	65	20	1.64	1.74	19	2.58	19	1.28	19	1.51
DEE	F	66	19	1.81	1.94	11	2.64	11	1.28	11	1.55
DEE	F	67	14	1.97	2.06	0	0.0	14	1.32	14	1.69
DEE	F	68	16	1.95	0.0	0	0.0	14	1.08	14	1.79
DEE	F	69	10	1.99	0.0	0	0.0	9	1.69	9	2.04
WEAN = 0.016			TYPE = -0.006			FEED = -0.027			WTAGE = -0.010		
DSF	M	59	13	1.82	0.0	10	2.50	8	2.03	8	2.12
DSF	M	60	24	1.98	0.0	16	2.56	16	1.96	16	2.17
DSF	M	61	16	2.09	0.0	13	2.38	13	1.86	13	2.19
DSF	M	62	25	1.89	0.0	20	2.35	20	2.00	20	2.14
DSF	M	63	16	1.88	1.92	14	2.29	14	2.54	14	2.22
DSF	M	64	32	2.00	2.09	17	2.41	17	1.90	17	2.00
DSF	M	65	28	1.74	1.82	25	2.64	25	1.67	25	1.70
DSF	M	66	28	1.89	1.97	25	2.52	25	2.12	25	1.97
DSF	M	67	31	1.75	1.83	0	0.0	19	2.14	19	1.98
DSF	M	68	26	2.19	0.0	0	0.0	24	2.06	24	2.33
DSF	M	69	31	1.90	0.0	0	0.0	30	2.01	30	2.13
WEAN = -0.001			TYPE = -0.014			FEED = 0.005			WTAGE = -0.002		
DSF	F	59	13	1.86	0.0	13	2.85	13	1.08	13	1.70
DSF	F	60	14	1.89	0.0	14	2.71	14	0.94	14	1.65
DSF	F	61	23	1.96	0.0	23	2.52	23	0.72	23	1.59
DSF	F	62	18	1.66	0.0	18	2.72	18	1.44	18	1.75
DSF	F	63	19	1.63	1.64	19	2.63	19	1.10	19	1.38
DSF	F	64	28	1.80	1.87	28	2.46	28	1.39	28	1.59
DSF	F	65	35	1.58	1.65	34	2.50	34	1.12	34	1.35
DSF	F	66	34	1.72	1.79	34	2.29	34	1.51	34	1.62
DSF	F	67	26	1.75	1.82	0	0.0	26	1.41	26	1.58
DSF	F	68	25	1.92	0.0	0	0.0	25	1.32	25	1.87
DSF	F	69	28	1.59	0.0	0	0.0	28	1.66	28	1.88
WEAN = -0.016			TYPE = 0.061			FEED = 0.065			WTAGE = 0.020		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
ETU	M	61	14	1.92	0.0	11	2.73	11	1.68	11	2.07
ETU	M	62	16	1.81	0.0	10	2.60	10	1.63	10	1.98
ETU	M	63	19	2.22	2.34	10	2.50	10	1.87	10	2.07
ETU	M	64	17	2.17	2.28	14	2.79	14	1.17	14	1.68
ETU	M	65	52	2.00	2.08	40	2.75	40	1.57	40	1.79
ETU	M	67	36	1.89	1.94	0	0.0	19	2.03	19	1.98
ETU	M	68	28	1.75	0.0	0	0.0	14	1.83	14	1.99
WEAN = -0.031			TYPE = -0.029			FEED = 0.046			WTAGE = -0.007		
ETU	F	61	20	1.83	0.0	20	2.60	20	0.70	20	1.47
ETU	F	62	13	1.65	0.0	12	2.58	12	1.20	12	1.62
ETU	F	63	26	2.20	2.33	19	2.68	19	1.22	19	1.68
ETU	F	64	27	1.87	1.96	10	2.70	10	0.99	10	1.46
ETU	F	65	19	1.77	1.85	6	2.50	6	1.04	6	1.40
ETU	F	67	28	1.63	1.70	0	0.0	20	0.82	20	1.33
ETU	F	68	25	1.60	0.0	0	0.0	0	0.0	0	0.0
WEAN = -0.050			TYPE = -0.007			FEED = -0.007			WTAGE = -0.037		
EZC	M	63	8	2.12	2.14	8	2.50	8	1.88	8	2.00
EZC	M	64	20	1.99	2.03	20	2.70	20	1.94	20	1.97
EZC	M	65	20	1.97	2.02	17	2.65	17	1.74	17	1.89
EZC	M	66	26	2.02	2.06	26	2.77	26	1.84	26	1.94
EZC	M	67	22	1.86	1.92	0	0.0	22	2.09	22	1.96
EZC	M	68	24	2.04	0.0	0	0.0	20	2.08	20	2.25
WEAN = -0.010			TYPE = -0.064			FEED = 0.051			WTAGE = 0.046		
EZC	F	63	19	1.82	1.86	19	2.63	19	1.43	19	1.63
EZC	F	64	10	1.94	1.97	10	2.20	10	1.36	10	1.69
EZC	F	65	21	1.81	1.84	20	2.35	20	1.52	20	1.70
EZC	F	66	17	1.75	1.82	17	2.53	17	1.44	17	1.61
EZC	F	67	19	1.78	1.83	0	0.0	19	1.40	19	1.62
EZC	F	68	27	1.77	0.0	0	0.0	24	1.38	24	1.80
WEAN = -0.017			TYPE = 0.033			FEED = -0.010			WTAGE = 0.021		

TABLE 1.1.1. SUMMARY OF THE DATA FOR THE YEAR 1970										
Year	Month	Day	Time	Location	Temperature (°C)	Humidity (%)	Wind Speed (km/h)	Wind Direction	Cloud Cover (%)	Visibility (km)
1970	Jan	1	08:00	Station A	15.2	65	12	SE	10	10
1970	Jan	1	12:00	Station A	18.5	70	15	SE	15	10
1970	Jan	1	16:00	Station A	16.8	68	10	SE	12	10
1970	Jan	1	20:00	Station A	14.1	62	8	SE	10	10
1970	Jan	1	24:00	Station A	12.5	58	5	SE	8	10
1970	Jan	2	00:00	Station A	11.8	55	3	SE	5	10
1970	Jan	2	04:00	Station A	10.2	52	2	SE	3	10
1970	Jan	2	08:00	Station A	9.5	50	1	SE	2	10
1970	Jan	2	12:00	Station A	12.1	55	5	SE	5	10
1970	Jan	2	16:00	Station A	15.4	60	10	SE	10	10
1970	Jan	2	20:00	Station A	18.7	65	15	SE	15	10
1970	Jan	2	24:00	Station A	21.3	70	20	SE	20	10
1970	Jan	3	00:00	Station A	23.8	75	25	SE	25	10
1970	Jan	3	04:00	Station A	26.1	80	30	SE	30	10
1970	Jan	3	08:00	Station A	28.5	85	35	SE	35	10
1970	Jan	3	12:00	Station A	30.2	90	40	SE	40	10
1970	Jan	3	16:00	Station A	31.8	92	45	SE	45	10
1970	Jan	3	20:00	Station A	32.5	95	50	SE	50	10
1970	Jan	3	24:00	Station A	33.1	98	55	SE	55	10
1970	Jan	4	00:00	Station A	33.5	100	60	SE	60	10
1970	Jan	4	04:00	Station A	33.8	100	65	SE	65	10
1970	Jan	4	08:00	Station A	34.2	100	70	SE	70	10
1970	Jan	4	12:00	Station A	34.5	100	75	SE	75	10
1970	Jan	4	16:00	Station A	34.8	100	80	SE	80	10
1970	Jan	4	20:00	Station A	35.1	100	85	SE	85	10
1970	Jan	4	24:00	Station A	35.4	100	90	SE	90	10
1970	Jan	5	00:00	Station A	35.7	100	95	SE	95	10
1970	Jan	5	04:00	Station A	36.0	100	100	SE	100	10
1970	Jan	5	08:00	Station A	36.3	100	105	SE	100	10
1970	Jan	5	12:00	Station A	36.6	100	110	SE	100	10
1970	Jan	5	16:00	Station A	36.9	100	115	SE	100	10
1970	Jan	5	20:00	Station A	37.2	100	120	SE	100	10
1970	Jan	5	24:00	Station A	37.5	100	125	SE	100	10
1970	Jan	6	00:00	Station A	37.8	100	130	SE	100	10
1970	Jan	6	04:00	Station A	38.1	100	135	SE	100	10
1970	Jan	6	08:00	Station A	38.4	100	140	SE	100	10
1970	Jan	6	12:00	Station A	38.7	100	145	SE	100	10
1970	Jan	6	16:00	Station A	39.0	100	150	SE	100	10
1970	Jan	6	20:00	Station A	39.3	100	155	SE	100	10
1970	Jan	6	24:00	Station A	39.6	100	160	SE	100	10
1970	Jan	7	00:00	Station A	39.9	100	165	SE	100	10
1970	Jan	7	04:00	Station A	40.2	100	170	SE	100	10
1970	Jan	7	08:00	Station A	40.5	100	175	SE	100	10
1970	Jan	7	12:00	Station A	40.8	100	180	SE	100	10
1970	Jan	7	16:00	Station A	41.1	100	185	SE	100	10
1970	Jan	7	20:00	Station A	41.4	100	190	SE	100	10
1970	Jan	7	24:00	Station A	41.7	100	195	SE	100	10
1970	Jan	8	00:00	Station A	42.0	100	200	SE	100	10
1970	Jan	8	04:00	Station A	42.3	100	205	SE	100	10
1970	Jan	8	08:00	Station A	42.6	100	210	SE	100	10
1970	Jan	8	12:00	Station A	42.9	100	215	SE	100	10
1970	Jan	8	16:00	Station A	43.2	100	220	SE	100	10
1970	Jan	8	20:00	Station A	43.5	100	225	SE	100	10
1970	Jan	8	24:00	Station A	43.8	100	230	SE	100	10
1970	Jan	9	00:00	Station A	44.1	100	235	SE	100	10
1970	Jan	9	04:00	Station A	44.4	100	240	SE	100	10
1970	Jan	9	08:00	Station A	44.7	100	245	SE	100	10
1970	Jan	9	12:00	Station A	45.0	100	250	SE	100	10
1970	Jan	9	16:00	Station A	45.3	100	255	SE	100	10
1970	Jan	9	20:00	Station A	45.6	100	260	SE	100	10
1970	Jan	9	24:00	Station A	45.9	100	265	SE	100	10
1970	Jan	10	00:00	Station A	46.2	100	270	SE	100	10
1970	Jan	10	04:00	Station A	46.5	100	275	SE	100	10
1970	Jan	10	08:00	Station A	46.8	100	280	SE	100	10
1970	Jan	10	12:00	Station A	47.1	100	285	SE	100	10
1970	Jan	10	16:00	Station A	47.4	100	290	SE	100	10
1970	Jan	10	20:00	Station A	47.7	100	295	SE	100	10
1970	Jan	10	24:00	Station A	48.0	100	300	SE	100	10
1970	Jan	11	00:00	Station A	48.3	100	305	SE	100	10
1970	Jan	11	04:00	Station A	48.6	100	310	SE	100	10
1970	Jan	11	08:00	Station A	48.9	100	315	SE	100	10
1970	Jan	11	12:00	Station A	49.2	100	320	SE	100	10
1970	Jan	11	16:00	Station A	49.5	100	325	SE	100	10
1970	Jan	11	20:00	Station A	49.8	100	330	SE	100	10
1970	Jan	11	24:00	Station A	50.1	100	335	SE	100	10
1970	Jan	12	00:00	Station A	50.4	100	340	SE	100	10
1970	Jan	12	04:00	Station A	50.7	100	345	SE	100	10
1970	Jan	12	08:00	Station A	51.0	100	350	SE	100	10
1970	Jan	12	12:00	Station A	51.3	100	355	SE	100	10
1970	Jan	12	16:00	Station A	51.6	100	360	SE	100	10
1970	Jan	12	20:00	Station A	51.9	100	365	SE	100	10
1970	Jan	12	24:00	Station A	52.2	100	370	SE	100	10
1970	Jan	13	00:00	Station A	52.5	100	375	SE	100	10
1970	Jan	13	04:00	Station A	52.8	100	380	SE	100	10
1970	Jan	13	08:00	Station A	53.1	100	385	SE	100	10
1970	Jan	13	12:00	Station A	53.4	100	390	SE	100	10
1970	Jan	13	16:00	Station A	53.7	100	395	SE	100	10
1970	Jan	13	20:00	Station A	54.0	100	400	SE	100	10
1970	Jan	13	24:00	Station A	54.3	100	405	SE	100	10
1970	Jan	14	00:00	Station A	54.6	100	410	SE	100	10
1970	Jan	14	04:00	Station A	54.9	100	415	SE	100	10
1970	Jan	14	08:00	Station A	55.2	100	420	SE	100	10
1970	Jan	14	12:00	Station A	55.5	100	425	SE	100	10
1970	Jan	14	16:00	Station A	55.8	100	430	SE	100	10
1970	Jan	14	20:00	Station A	56.1	100	435	SE	100	10
1970	Jan	14	24:00	Station A	56.4	100	440	SE	100	10
1970	Jan	15	00:00	Station A	56.7	100	445	SE	100	10
1970	Jan	15	04:00	Station A	57.0	100	450	SE	100	10
1970	Jan	15	08:00	Station A	57.3	100	455	SE	100	10
1970	Jan	15	12:00	Station A	57.6	100	460	SE	100	10
1970	Jan	15	16:00	Station A	57.9	100	465	SE	100	10
1970	Jan	15	20:00	Station A	58.2	100	470	SE	100	10
1970	Jan	15	24:00	Station A	58.5	100	475	SE	100	10
1970	Jan	16	00:00	Station A	58.8	100	480	SE	100	10
1970	Jan	16	04:00	Station A	59.1	100	485	SE	100	10
1970	Jan	16	08:00	Station A	59.4	100	490	SE	100	10
1970	Jan	16	12:00	Station A	59.7	100	495	SE	100	10
1970	Jan	16	16:00	Station A	60.0	100	500	SE	100	10
1970	Jan	16	20:00	Station A	60.3	100	505	SE	100	10
1970	Jan	16	24:00	Station A	60.6	100	510	SE	100	10
1970	Jan	17	00:00	Station A	60.9	100	515	SE	100	10
1970	Jan	17	04:00	Station A	61.2	100	520	SE	100	10
1970	Jan	17	08:00	Station A	61.5	100	525	SE	100	10
1970	Jan	17	12:00	Station A	61.8	100	530	SE	100	10
1970	Jan	17	16:00	Station A	62.1	100	535	SE	100	10
1970	Jan	17	20:00	Station A	62.4	100	540	SE	100	10
1970	Jan	17	24:00	Station A	62.7	100	545	SE	100	10
1970	Jan	18	00:00	Station A	63.0	100	550	SE	100	10
1970	Jan	18	04:00	Station A	63.3	100	555	SE	100	10
1970	Jan	18	08:00	Station A	63.6	100	560	SE	100	10
1970	Jan	18	12:00	Station A	63.9	100	565	SE	100	10
1970	Jan	18	16:00	Station A	64.2	100	570	SE	100	10
1970	Jan	18	20:00	Station A	64.5	100	575	SE	100	10
1970	Jan	18	24:00	Station A	64.8	100	580	SE	100	10
1970	Jan	19	00:00	Station A	65.1	100	585	SE	100	10
1970	Jan	19	04:00	Station A	65.4	100	590	SE	100	10
1970	Jan	19	08:00	Station A	65.7	100	595	SE	100	10
1970	Jan	19	12:00	Station A	66.0	100	600	SE	100	10
1970	Jan	19	16:00	Station A	66.3	100	605	SE	100	10
1970	Jan	19	20:00	Station A	66.6	100	610	SE	100	10
1970	Jan	19	24:00	Station A	66.9	100	615	SE	100	10
1970	Jan	20	00:00	Station A	67.2	100	620	SE	100	10
1970	Jan	20	04:00	Station A	67.5	100	625	SE	100	10
1970	Jan	20	08:00	Station A	67.8	100	630	SE	100	10
1970	Jan	20	12:00	Station A	68.1	100	635	SE	100	10
1970	Jan	20	16:00	Station A	68.4	100	640	SE	100	10
1970	Jan									

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
FSI	M	62	11	1.94	1.96	11	2.27	11	2.35	11	2.33
FSI	M	63	9	1.96	2.03	8	2.13	8	2.30	8	2.14
FSI	M	64	14	1.69	1.73	14	2.71	14	2.09	14	1.87
FSI	M	65	19	1.82	1.87	10	2.30	19	2.11	19	1.94
FSI	M	66	18	1.68	1.75	17	2.65	17	1.93	17	1.81
FSI	M	67	23	1.80	1.85	0	0.0	22	1.86	22	1.81
FSI	M	68	24	1.90	0.0	0	0.0	24	2.24	24	2.23
FSI	M	69	25	1.62	0.0	0	0.0	24	1.91	24	1.93
WEAN = -0.024			TYPE = -0.090			FEED = -0.041			WTAGE = -0.017		
FSI	F	62	14	1.64	1.69	12	2.33	12	1.52	12	1.78
FSI	F	63	11	1.80	1.85	10	2.40	11	1.56	11	1.68
FSI	F	64	6	1.47	1.49	6	2.83	6	1.35	6	1.41
FSI	F	65	16	1.60	1.66	15	2.60	15	1.60	15	1.60
FSI	F	66	20	1.58	1.63	19	2.53	19	1.48	19	1.54
FSI	F	67	16	1.68	1.76	0	0.0	16	1.43	16	1.56
FSI	F	68	29	1.72	0.0	0	0.0	27	1.63	27	1.88
FSI	F	69	33	1.62	0.0	0	0.0	32	1.81	32	1.87
WEAN = 0.000			TYPE = -0.050			FEED = 0.039			WTAGE = 0.034		
GDT	M	59	14	2.17	0.0	9	2.29	13	1.81	13	2.21
GDT	M	60	21	1.71	0.0	20	2.85	20	1.65	20	1.88
GDT	M	61	11	2.11	0.0	11	2.54	11	1.75	11	2.15
GDT	M	62	19	1.74	1.78	14	2.93	14	1.83	14	2.00
GDT	M	63	33	1.75	1.83	18	2.78	18	1.98	18	1.81
GDT	M	64	21	1.86	1.92	20	2.40	20	1.74	20	1.80
GDT	M	65	33	1.54	1.63	20	2.65	31	2.04	31	1.78
GDT	M	66	32	1.41	1.47	7	2.57	29	1.77	29	1.59
GDT	M	67	7	1.75	1.81	0	0.0	5	2.28	5	2.00
GDT	M	68	18	1.77	0.0	0	0.0	6	1.99	6	2.07
GDT	M	69	30	1.78	0.0	0	0.0	7	2.31	7	2.25
WEAN = -0.027			TYPE = 0.014			FEED = 0.039			WTAGE = -0.027		
GDT	F	59	12	1.70	0.0	12	2.88	12	1.51	12	1.80
GDT	F	60	14	1.58	0.0	14	3.00	14	1.27	14	1.63
GDT	F	61	22	1.60	0.0	21	3.29	21	1.23	21	1.62
GDT	F	62	15	1.63	1.65	15	3.00	15	1.11	15	1.59
GDT	F	63	25	1.66	1.72	25	3.16	25	1.42	25	1.54
GDT	F	64	26	1.72	1.78	26	2.65	26	1.09	26	1.43
GDT	F	65	33	1.47	1.53	31	2.48	31	1.45	31	1.48
GDT	F	66	38	1.43	1.52	38	2.82	38	1.33	38	1.39
GDT	F	67	34	1.40	1.48	0	0.0	31	1.62	31	1.52
GDT	F	68	25	1.62	0.0	0	0.0	25	1.35	25	1.70
GDT	F	69	26	1.70	0.0	0	0.0	26	1.58	26	1.84
WEAN = -0.011			TYPE = 0.069			FEED = 0.028			WTAGE = 0.003		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
GUR	M	63	25	1.90	1.96	20	2.85	22	1.66	22	1.78
GUR	M	64	33	1.93	1.98	31	2.71	31	0.66	31	1.42
GUR	M	65	28	1.73	1.80	0	0.0	28	2.33	28	1.96
GUR	M	66	22	1.82	1.85	19	2.79	19	1.80	19	1.80
GUR	M	67	32	1.82	1.88	0	0.0	29	2.41	29	2.07
GUR	M	68	30	2.02	0.0	0	0.0	27	2.44	27	2.42
GUR	M	69	62	1.83	0.0	0	0.0	48	2.16	48	2.18
WEAN = -0.002			TYPE = 0.010		FEED = 0.178		WTAGE = 0.117				
GUR	F	63	30	1.79	1.83	27	2.78	27	1.23	27	1.51
GUR	F	64	32	1.79	1.86	28	2.46	28	0.48	28	1.27
GUR	F	65	45	1.63	1.67	0	0.0	42	1.63	42	1.63
GUR	F	66	30	1.66	1.69	22	2.91	25	1.04	25	1.38
GUR	F	67	43	1.66	1.71	0	0.0	42	1.71	42	1.67
GUR	F	68	50	1.72	0.0	0	0.0	45	1.78	45	1.95
GUR	F	69	60	1.67	0.0	0	0.0	35	1.97	35	1.99
WEAN = -0.013			TYPE = -0.064		FEED = 0.171		WTAGE = 0.104				
HDA	M	61	40	1.99	0.0	23	2.35	24	1.89	24	2.15
HDA	M	62	45	2.04	0.0	27	2.26	27	2.02	27	2.24
HDA	M	63	13	2.04	2.07	11	2.18	11	2.05	11	2.05
HDA	M	64	3	1.73	1.74	2	2.50	2	1.74	2	1.87
HDA	M	65	18	1.96	2.01	14	2.14	18	2.01	18	1.98
HDA	M	66	4	1.81	1.90	4	2.25	4	1.93	4	1.87
HDA	M	67	6	1.86	1.96	0	0.0	6	1.86	6	1.86
HDA	M	69	41	1.88	0.0	0	0.0	37	1.95	37	2.11
WEAN = -0.019			TYPE = 0.035		FEED = -0.002		WTAGE = -0.013				
HDA	F	61	40	1.82	0.0	14	1.86	14	1.10	14	1.68
HDA	F	62	39	1.77	0.0	39	2.54	39	1.15	39	1.68
HDA	F	63	18	1.80	1.83	11	2.00	11	1.38	11	1.60
HDA	F	64	2	2.11	2.20	2	2.00	2	1.55	2	1.88
HDA	F	65	16	1.73	1.79	11	2.36	14	1.34	14	1.58
HDA	F	66	8	1.87	1.91	4	2.00	4	1.54	4	1.64
HDA	F	67	8	1.71	1.76	0	0.0	6	1.54	6	1.57
HDA	F	69	33	1.77	0.0	0	0.0	29	1.29	29	1.75
WEAN = -0.005			TYPE = 0.001		FEED = 0.025		WTAGE = 0.007				

Table 1. Summary of the data collected during the field survey.

Group 1: Lowland Forest						Group 2: Upland Forest				Group 3: Mixed Forest		Group 4: Edge Forest	
Species	Abundance	Frequency	Mean	SD	Range	Species	Abundance	Frequency	Mean	SD	Range	Species	Abundance
1.1	10	1	10	0	10	2.1	5	1	5	0	5	3.1	15
1.2	20	2	20	0	20	2.2	10	2	10	0	10	3.2	25
1.3	30	3	30	0	30	2.3	15	3	15	0	15	3.3	35
1.4	40	4	40	0	40	2.4	20	4	20	0	20	3.4	45
1.5	50	5	50	0	50	2.5	25	5	25	0	25	3.5	55
1.6	60	6	60	0	60	2.6	30	6	30	0	30	3.6	65
1.7	70	7	70	0	70	2.7	35	7	35	0	35	3.7	75
1.8	80	8	80	0	80	2.8	40	8	40	0	40	3.8	85
1.9	90	9	90	0	90	2.9	45	9	45	0	45	3.9	95
1.10	100	10	100	0	100	2.10	50	10	50	0	50	3.10	100
Group 1 Total						Group 2 Total				Group 3 Total		Group 4 Total	
1.11	110	11	110	0	110	2.11	55	11	55	0	55	3.11	110
1.12	120	12	120	0	120	2.12	60	12	60	0	60	3.12	120
1.13	130	13	130	0	130	2.13	65	13	65	0	65	3.13	130
1.14	140	14	140	0	140	2.14	70	14	70	0	70	3.14	140
1.15	150	15	150	0	150	2.15	75	15	75	0	75	3.15	150
1.16	160	16	160	0	160	2.16	80	16	80	0	80	3.16	160
1.17	170	17	170	0	170	2.17	85	17	85	0	85	3.17	170
1.18	180	18	180	0	180	2.18	90	18	90	0	90	3.18	180
1.19	190	19	190	0	190	2.19	95	19	95	0	95	3.19	190
1.20	200	20	200	0	200	2.20	100	20	100	0	100	3.20	200
Group 1 Grand Total						Group 2 Grand Total				Group 3 Grand Total		Group 4 Grand Total	
1.21	210	21	210	0	210	2.21	105	21	105	0	105	3.21	210
1.22	220	22	220	0	220	2.22	110	22	110	0	110	3.22	220
1.23	230	23	230	0	230	2.23	115	23	115	0	115	3.23	230
1.24	240	24	240	0	240	2.24	120	24	120	0	120	3.24	240
1.25	250	25	250	0	250	2.25	125	25	125	0	125	3.25	250
1.26	260	26	260	0	260	2.26	130	26	130	0	130	3.26	260
1.27	270	27	270	0	270	2.27	135	27	135	0	135	3.27	270
1.28	280	28	280	0	280	2.28	140	28	140	0	140	3.28	280
1.29	290	29	290	0	290	2.29	145	29	145	0	145	3.29	290
1.30	300	30	300	0	300	2.30	150	30	150	0	150	3.30	300
Group 1 Grand Total						Group 2 Grand Total				Group 3 Grand Total		Group 4 Grand Total	
1.31	310	31	310	0	310	2.31	155	31	155	0	155	3.31	310
1.32	320	32	320	0	320	2.32	160	32	160	0	160	3.32	320
1.33	330	33	330	0	330	2.33	165	33	165	0	165	3.33	330
1.34	340	34	340	0	340	2.34	170	34	170	0	170	3.34	340
1.35	350	35	350	0	350	2.35	175	35	175	0	175	3.35	350
1.36	360	36	360	0	360	2.36	180	36	180	0	180	3.36	360
1.37	370	37	370	0	370	2.37	185	37	185	0	185	3.37	370
1.38	380	38	380	0	380	2.38	190	38	190	0	190	3.38	380
1.39	390	39	390	0	390	2.39	195	39	195	0	195	3.39	390
1.40	400	40	400	0	400	2.40	200	40	200	0	200	3.40	400
Group 1 Grand Total						Group 2 Grand Total				Group 3 Grand Total		Group 4 Grand Total	
1.41	410	41	410	0	410	2.41	205	41	205	0	205	3.41	410
1.42	420	42	420	0	420	2.42	210	42	210	0	210	3.42	420
1.43	430	43	430	0	430	2.43	215	43	215	0	215	3.43	430
1.44	440	44	440	0	440	2.44	220	44	220	0	220	3.44	440
1.45	450	45	450	0	450	2.45	225	45	225	0	225	3.45	450
1.46	460	46	460	0	460	2.46	230	46	230	0	230	3.46	460
1.47	470	47	470	0	470	2.47	235	47	235	0	235	3.47	470
1.48	480	48	480	0	480	2.48	240	48	240	0	240	3.48	480
1.49	490	49	490	0	490	2.49	245	49	245	0	245	3.49	490
1.50	500	50	500	0	500	2.50	250	50	250	0	250	3.50	500
Group 1 Grand Total						Group 2 Grand Total				Group 3 Grand Total		Group 4 Grand Total	
1.51	510	51	510	0	510	2.51	255	51	255	0	255	3.51	510
1.52	520	52	520	0	520	2.52	260	52	260	0	260	3.52	520
1.53	530	53	530	0	530	2.53	265	53	265	0	265	3.53	530
1.54	540	54	540	0	540	2.54	270	54	270	0	270	3.54	540
1.55	550	55	550	0	550	2.55	275	55	275	0	275	3.55	550
1.56	560	56	560	0	560	2.56	280	56	280	0	280	3.56	560
1.57	570	57	570	0	570	2.57	285	57	285	0	285	3.57	570
1.58	580	58	580	0	580	2.58	290	58	290	0	290	3.58	580
1.59	590	59	590	0	590	2.59	295	59	295	0	295	3.59	590
1.60	600	60	600	0	600	2.60	300	60	300	0	300	3.60	600
Group 1 Grand Total						Group 2 Grand Total				Group 3 Grand Total		Group 4 Grand Total	
1.61	610	61	610	0	610	2.61	305	61	305	0	305	3.61	610
1.62	620	62	620	0	620	2.62	310	62	310	0	310	3.62	620
1.63	630	63	630	0	630	2.63	315	63	315	0	315	3.63	630
1.64	640	64	640	0	640	2.64	320	64	320	0	320	3.64	640
1.65	650	65	650	0	650	2.65	325	65	325	0	325	3.65	650
1.66	660	66	660	0	660	2.66	330	66	330	0	330	3.66	660
1.67	670	67	670	0	670	2.67	335	67	335	0	335	3.67	670
1.68	680	68	680	0	680	2.68	340	68	340	0	340	3.68	680
1.69	690	69	690	0	690	2.69	345	69	345	0	345	3.69	690
1.70	700	70	700	0	700	2.70	350	70	350	0	350	3.70	700
Group 1 Grand Total						Group 2 Grand Total				Group 3 Grand Total		Group 4 Grand Total	
1.71	710	71	710	0	710	2.71	355	71	355	0	355	3.71	710
1.72	720	72	720	0	720	2.72	360	72	360	0	360	3.72	720
1.73	730	73	730	0	730	2.73	365	73	365	0	365	3.73	730
1.74	740	74	740	0	740	2.74	370	74	370	0	370	3.74	740
1.75	750	75	750	0	750	2.75	375	75	375	0	375	3.75	750
1.76	760	76	760	0	760	2.76	380	76	380	0	380	3.76	760
1.77	770	77	770	0	770	2.77	385	77	385	0	385	3.77	770
1.78	780	78	780	0	780	2.78	390	78	390	0	390	3.78	780
1.79	790	79	790	0	790	2.79	395	79	395	0	395	3.79	790
1.80	800	80	800	0	800	2.80	400	80	400	0	400	3.80	800
Group 1 Grand Total						Group 2 Grand Total				Group 3 Grand Total		Group 4 Grand Total	
1.81	810	81	810	0	810	2.81	405	81	405	0	405	3.81	810
1.82	820	82	820	0	820	2.82	410	82	410	0	410	3.82	820
1.83	830	83	830	0	830	2.83	415	83	415	0	415	3.83	830
1.84	840	84	840	0	840	2.84	420	84	420	0	420	3.84	840
1.85	850	85	850	0	850	2.85	425	85	425	0	425	3.85	850
1.86	860	86	860	0	860	2.86	430	86	430	0	430	3.86	860
1.87	870	87	870	0	870	2.87	435	87	435	0	435	3.87	870
1.88	880	88	880	0	880	2.88	440	88	440	0	440	3.88	880
1.89	890	89	890	0	890	2.89	445	89	445	0	445	3.89	890
1.90	900	90	900	0	900	2.90	450	90	450	0	450	3.90	900
Group 1 Grand Total						Group 2 Grand Total				Group 3 Grand Total		Group 4 Grand Total	
1.91	910	91	910	0	910	2.91	455	91	455	0	455	3.91	

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
IAY	M	59	15	2.41	0.0	15	3.27	15	1.47	15	2.19
IAY	M	60	18	2.13	0.0	17	3.06	17	1.88	17	2.22
IAY	M	61	18	1.96	0.0	17	3.06	17	1.51	17	1.96
IAY	M	62	19	1.97	2.05	18	3.05	18	1.25	18	1.87
IAY	M	63	9	1.99	2.10	9	2.89	9	1.56	9	1.76
IAY	M	64	15	1.80	1.86	14	2.64	15	2.09	15	1.93
IAY	M	65	16	1.66	1.72	15	2.80	15	2.23	15	1.91
IAY	M	66	15	2.02	2.07	15	2.40	15	2.30	15	2.14
IAY	M	67	14	1.70	1.77	0	0.0	12	2.47	12	2.05
IAY	M	68	11	1.85	0.0	0	0.0	10	1.91	10	2.08
IAY	M	69	9	1.82	0.0	0	0.0	9	2.40	9	2.26
WEAN = -0.049			TYPE = 0.104			FEED = 0.098			WTAGE = 0.002		

IAY	F	59	12	2.25	0.0	12	2.50	12	1.22	12	1.97
IAY	F	60	13	1.99	0.0	13	2.69	13	1.32	13	1.88
IAY	F	61	18	1.76	0.0	17	2.47	17	1.29	17	1.74
IAY	F	62	18	1.90	1.95	16	2.69	16	1.19	16	1.77
IAY	F	63	19	1.79	2.11	18	2.33	18	1.27	18	1.54
IAY	F	64	22	1.73	1.82	22	2.45	22	1.59	22	1.67
IAY	F	65	18	1.48	1.55	17	2.53	17	1.83	17	1.64
IAY	F	66	15	1.71	1.79	14	2.50	14	1.60	14	1.66
IAY	F	67	21	1.58	1.64	0	0.0	20	1.77	20	1.68
IAY	F	68	14	1.88	0.0	0	0.0	14	1.36	14	1.84
IAY	F	69	16	1.73	0.0	0	0.0	16	1.97	16	2.01
WEAN = -0.037 TYPE = 0.015 FEED = 0.065 WTAGE = 0.001											

IBO	M	59	32	1.88	0.0	29	2.65	29	2.08	29	2.17
IBO	M	60	25	2.00	0.0	24	2.71	24	2.21	24	2.30
IBO	M	61	31	1.72	0.0	24	2.54	24	2.22	24	2.15
IBO	M	62	36	1.77	0.0	32	2.66	32	2.01	32	2.08
IBO	M	63	26	1.85	1.91	24	2.33	24	1.86	24	1.87
IBO	M	64	32	1.83	1.87	22	2.00	23	1.84	23	1.87
IBO	M	65	35	1.76	1.80	27	2.44	28	1.75	28	1.77
IBO	M	66	37	1.88	1.94	31	1.74	31	1.94	31	1.93
IBO	M	67	42	1.92	1.98	0	0.0	31	1.95	31	1.94
IBO	M	68	33	1.98	0.0	0	0.0	31	1.78	31	2.10
IBO	M	69	45	1.90	0.0	0	0.0	33	2.21	33	2.24
WEAN = 0.008 TYPE = 0.116 FEED = -0.016 WTAGE = -0.010											

[illegible]

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
JNT	M	59	16	2.06	0.0	12	2.42	12	2.54	12	2.48
JNT	M	60	12	2.47	0.0	12	2.00	12	2.70	12	2.77
JNT	M	61	15	2.22	0.0	13	2.54	13	2.31	13	2.46
JNT	M	62	18	2.25	0.0	11	2.36	11	2.35	11	2.50
JNT	M	63	24	2.41	2.51	22	2.27	22	2.31	22	2.38
JNT	M	64	23	2.30	2.37	15	2.40	15	2.19	15	2.23
JNT	M	65	21	1.89	1.99	17	2.41	17	1.88	17	1.90
JNT	M	66	16	2.06	2.21	15	2.20	15	2.14	15	2.08
JNT	M	67	22	2.28	2.43	0	0.0	14	2.26	14	2.26
JNT	M	68	26	2.20	0.0	0	0.0	15	1.74	15	2.24
JNT	M	69	13	2.37	0.0	0	0.0	9	1.72	9	2.30
WEAN = -0.003			TYPE = 0.000			FEED = -0.081			WTAGE = -0.048		
JNT	F	60	19	1.93	0.0	19	2.63	19	1.63	19	1.98
JNT	F	61	7	1.97	0.0	10	2.50	10	1.10	7	1.77
JNT	F	62	25	1.91	0.0	21	2.48	21	1.30	21	1.82
JNT	F	63	21	2.06	2.17	21	2.33	21	1.56	21	1.81
JNT	F	64	29	2.14	2.25	26	2.38	27	1.56	27	1.87
JNT	F	65	23	1.80	1.85	22	2.14	22	1.31	22	1.59
JNT	F	66	17	1.70	1.83	17	2.06	17	1.54	17	1.62
JNT	F	67	21	1.96	2.13	0	0.0	19	1.61	19	1.82
JNT	F	68	23	2.01	0.0	0	0.0	21	1.33	21	1.95
JNT	F	69	20	2.19	0.0	0	0.0	17	1.42	17	2.06
WEAN = 0.010			TYPE = 0.091			FEED = -0.002			WTAGE = 0.005		
MCI	M	59	62	1.71	0.0	62	2.61	62	1.59	62	1.86
MCI	M	60	44	1.97	0.0	42	2.71	42	1.79	42	2.09
MCI	M	61	65	1.94	0.0	64	2.58	64	1.86	64	2.10
MCI	M	62	63	1.98	0.0	60	2.67	60	1.84	60	2.12
MCI	M	63	70	2.07	2.10	58	2.86	58	1.58	58	1.86
MCI	M	64	55	1.87	1.91	53	2.47	53	1.99	53	1.93
MCI	M	65	65	1.85	1.89	63	2.46	63	1.85	63	1.84
MCI	M	66	72	1.85	1.90	69	2.42	69	1.84	69	1.84
MCI	M	67	72	1.77	1.83	0	0.0	70	1.79	70	1.78
MCI	M	68	69	1.86	0.0	0	0.0	67	2.20	67	2.22
MCI	M	69	79	1.84	0.0	0	0.0	78	1.74	78	2.02
WEAN = -0.007			TYPE = 0.032			FEED = 0.021			WTAGE = -0.000		
MCI	F	59	68	1.66	0.0	68	2.87	68	0.87	68	1.49
MCI	F	60	47	1.78	0.0	47	2.89	47	1.16	47	1.69
MCI	F	61	62	1.76	0.0	62	2.55	62	0.92	62	1.57
MCI	F	62	62	1.87	0.0	59	2.81	59	1.25	59	1.78
MCI	F	63	57	1.87	0.0	56	2.70	56	1.07	56	1.70
MCI	F	64	51	1.81	1.84	50	2.32	50	1.08	50	1.55
MCI	F	65	59	1.58	1.62	57	2.47	57	1.24	57	1.45
MCI	F	66	45	1.63	1.68	45	2.36	45	1.42	45	1.54
MCI	F	67	70	1.63	1.67	0	0.0	70	1.22	70	1.45
MCI	F	68	76	1.74	0.0	0	0.0	75	1.55	75	1.86
MCI	F	69	68	1.70	0.0	0	0.0	67	1.41	67	1.80
WEAN = -0.009			TYPE = 0.075			FEED = 0.053			WTAGE = 0.014		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
MFM	M	59	5	2.04	0.0	5	3.20	5	1.86	5	2.16
MFM	M	60	5	2.09	0.0	5	2.80	5	2.30	5	2.39
MFM	M	61	4	2.16	0.0	4	3.25	4	2.26	4	2.41
MFM	M	62	6	2.10	0.0	5	2.80	5	2.46	5	2.46
MFM	M	63	5	2.07	2.17	5	2.40	5	2.29	5	2.18
MFM	M	64	6	2.19	2.32	6	2.33	6	2.33	6	2.25
MFM	M	65	6	1.82	1.95	6	2.83	6	1.99	6	1.89
MFM	M	66	9	1.90	1.98	9	3.11	9	2.46	9	2.12
MFM	M	67	12	1.88	1.94	0	0.0	10	2.67	10	2.27
MFM	M	68	13	2.01	0.0	0	0.0	13	2.62	13	2.45
MFM	M	69	19	2.08	0.0	0	0.0	17	2.24	17	2.34
WEAN = -0.009			TYPE = 0.021			FEED = 0.031			WTAGE = 0.007		
MFM	F	61	4	1.93	0.0	4	3.25	4	1.14	4	1.77
MFM	F	62	6	1.95	0.0	6	3.00	6	1.61	6	1.98
MFM	F	63	5	1.94	2.00	5	2.00	5	1.53	5	1.76
MFM	F	64	6	2.05	2.18	6	2.33	6	1.53	6	1.82
MFM	F	65	3	1.58	1.73	3	3.00	3	1.54	3	1.57
MFM	F	66	10	1.76	1.89	9	2.22	9	1.51	9	1.66
MFM	F	67	11	1.78	1.88	0	0.0	11	2.10	11	1.92
MFM	F	68	19	1.87	0.0	0	0.0	19	2.07	19	2.13
MFM	F	69	21	1.84	0.0	0	0.0	20	1.41	20	1.85
WEAN = -0.015			TYPE = 0.153			FEED = 0.038			WTAGE = 0.021		
OHB	M	60	8	2.48	0.0	8	3.63	8	1.24	8	2.12
OHB	M	61	13	1.96	0.0	12	3.25	12	1.57	12	1.98
OHB	M	62	10	2.12	0.0	8	2.75	8	1.19	8	1.90
OHB	M	63	13	1.93	1.98	12	3.08	12	0.88	12	1.47
OHB	M	64	9	1.92	1.97	9	3.00	9	1.02	9	1.53
OHB	M	65	15	1.94	2.03	11	3.00	11	1.21	11	1.61
OHB	M	66	12	2.10	2.19	8	2.63	8	1.95	8	2.11
OHB	M	67	15	1.98	2.09	0	0.0	4	1.94	4	2.08
WEAN = -0.029			TYPE = 0.110			FEED = 0.054			WTAGE = -0.024		
OHB	F	59	7	1.65	0.0	7	3.29	7	0.71	7	1.41
OHB	F	60	11	2.16	0.0	10	2.80	10	0.66	10	1.67
OHB	F	61	8	1.80	0.0	7	2.71	7	1.10	7	1.67
OHB	F	62	18	1.84	0.0	18	2.94	18	0.42	18	1.39
OHB	F	63	8	1.79	1.82	5	2.60	5	0.41	5	1.15
OHB	F	64	11	1.61	1.72	11	2.91	11	0.54	11	1.14
OHB	F	65	4	1.84	1.93	4	2.50	4	0.74	4	1.35
OHB	F	65	14	1.75	1.91	11	2.91	11	1.22	11	1.50
OHB	F	67	12	1.76	1.88	0	0.0	7	1.49	7	1.70
WEAN = -0.025			TYPE = 0.035			FEED = 0.080			WTAGE = -0.009		



APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
OTH	M	62	16	1.76	1.81	16	3.06	16	1.59	16	1.89
OTH	M	63	32	1.77	1.88	30	2.83	30	2.14	30	1.94
OTH	M	64	23	1.87	1.97	23	2.83	23	2.17	23	2.00
OTH	M	65	25	1.61	1.69	23	2.43	23	1.54	23	1.60
OTH	M	66	25	1.61	1.68	25	2.80	25	1.57	25	1.59
OTH	M	67	32	1.28	1.34	0	0.0	29	1.11	29	1.22
OTH	M	68	35	1.71	0.0	0	0.0	26	1.72	26	1.90
OTH	M	69	19	1.65	0.0	0	0.0	19	1.67	19	1.85
WEAN = -0.037			TYPE = 0.081		FEED = -0.076			WTAGE = -0.042			
OTH	F	62	13	1.62	1.69	13	2.92	13	0.99	13	1.53
OTH	F	63	22	1.55	1.61	21	2.62	21	1.30	21	1.44
OTH	F	64	27	1.85	1.94	25	2.64	25	1.13	25	1.52
OTH	F	65	23	1.54	1.63	22	2.45	22	0.90	22	1.29
OTH	F	66	39	1.36	1.45	38	2.82	38	1.28	38	1.34
OTH	F	67	20	1.13	1.18	0	0.0	18	0.89	18	1.05
OTH	F	68	28	1.53	0.0	0	0.0	26	1.05	26	1.51
OTH	F	69	29	1.48	0.0	0	0.0	26	1.23	26	1.56
WEAN = -0.039			TYPE = 0.001		FEED = 0.001			WTAGE = -0.001			
RIO	M	59	11	1.68	0.0	11	3.45	11	2.07	11	2.06
RIO	M	61	9	1.89	0.0	9	3.00	9	1.78	9	2.04
RIO	M	62	10	1.80	0.0	10	2.80	10	2.00	10	2.09
RIO	M	63	7	1.69	0.0	6	3.00	6	1.68	6	1.89
RIO	M	64	11	1.77	1.87	11	2.73	11	2.18	11	1.84
RIO	M	65	13	1.76	0.0	12	1.83	12	1.80	12	1.97
RIO	M	66	11	1.62	1.73	11	2.18	11	1.72	11	1.66
RIO	M	67	10	2.04	2.15	0	0.0	9	1.88	9	1.98
RIO	M	68	15	2.11	0.0	0	0.0	13	2.07	13	2.31
RIO	M	69	20	2.02	0.0	0	0.0	18	1.76	18	2.12
WEAN = 0.035			TYPE = 0.204		FEED = -0.015			WTAGE = 0.011			
RIO	F	59	9	1.66	0.0	9	3.44	9	1.36	9	1.71
RIO	F	60	11	1.55	0.0	11	3.09	11	1.56	11	1.99
RIO	F	61	11	1.68	0.0	11	2.45	11	1.38	11	1.73
RIO	F	62	5	1.63	0.0	4	3.00	4	1.45	4	1.74
RIO	F	63	12	1.61	0.0	11	3.18	11	1.08	11	1.56
RIO	F	64	13	1.54	1.64	13	2.85	13	1.64	13	1.53
RIO	F	65	16	1.54	0.0	16	1.22	16	2.19	16	2.02
RIO	F	66	17	1.60	1.69	17	2.18	17	1.04	17	1.36
RIO	F	67	20	1.76	1.88	0	0.0	20	1.32	20	1.56
RIO	F	68	9	2.00	0.0	0	0.0	9	1.53	9	2.01
RIO	F	69	21	1.87	0.0	0	0.0	21	1.18	21	1.86
WEAN = 0.028			TYPE = 0.206		FEED = -0.019			WTAGE = -0.002			

Table 1. Summary of data for the 1990-1991 season.

Station		Date		Time		Wind		Temp		Humid		Pres	
1	1990-1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
2	1990-1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
3	1990-1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
4	1990-1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
5	1990-1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
SBF	M	59	9	2.07	0.0	9	2.89	9	2.50	9	2.46
SBF	M	60	5	2.30	0.0	5	2.40	5	2.07	5	2.40
SBF	M	61	15	2.20	0.0	13	2.61	13	2.15	13	2.38
SBF	M	62	13	2.24	0.0	11	2.27	11	1.91	11	2.29
SBF	M	63	11	2.24	2.32	11	2.18	11	2.12	11	2.19
SBF	M	64	15	2.28	2.34	13	1.85	13	2.20	13	2.23
SBF	M	65	6	2.07	2.14	6	2.33	6	2.32	6	2.17
SBF	M	66	7	2.39	2.48	0	0.0	0	0.0	0	0.0
SBF	M	67	11	2.40	2.54	0	0.0	9	2.03	9	2.25
SBF	M	68	17	2.54	0.0	0	0.0	0	0.0	0	0.0
SBF	M	69	14	2.31	0.0	0	0.0	9	1.89	9	2.43
WEAN = 0.030			TYPE = 0.146			FEED = -0.032			WTAGE = -0.009		
SBF	F	59	14	1.93	0.0	13	2.08	13	2.15	13	2.22
SBF	F	60	18	2.03	0.0	17	2.59	17	1.36	17	1.92
SBF	F	61	11	1.90	0.0	21	2.50	12	1.62	12	1.96
SBF	F	62	12	2.00	0.0	11	1.82	11	1.50	11	1.96
SBF	F	63	10	2.08	2.14	9	2.22	9	1.42	9	1.80
SBF	F	64	9	1.91	2.04	8	2.00	8	1.57	8	1.75
SBF	F	65	17	1.94	2.01	16	2.19	16	1.46	16	1.75
SBF	F	66	7	2.04	2.06	6	1.67	6	1.02	6	1.64
SBF	F	67	16	2.05	2.22	0	0.0	16	1.48	16	1.81
SBF	F	68	14	2.19	0.0	0	0.0	0	0.0	0	0.0
SBF	F	69	19	2.21	0.0	0	0.0	13	1.38	13	2.01
WEAN = 0.022			TYPE = 0.064			FEED = -0.041			WTAGE = -0.022		
UP	M	62	24	2.13	0.0	23	2.91	23	1.68	23	2.15
UP	M	63	16	2.23	2.28	16	2.44	16	1.74	16	1.99
UP	M	64	22	1.94	2.03	22	2.14	22	1.92	22	1.93
UP	M	65	14	2.24	2.27	14	2.43	14	1.99	14	2.13
UP	M	66	26	2.05	2.12	25	2.32	25	1.48	25	1.80
UP	M	67	38	1.64	1.72	0	0.0	38	1.87	38	1.74
UP	M	68	36	1.85	0.0	0	0.0	32	1.53	32	1.91
UP	M	69	45	1.81	0.0	0	0.0	40	1.72	40	1.97
WEAN = -0.059			TYPE = 0.126			FEED = -0.015			WTAGE = -0.026		
UP	F	62	14	1.90	0.0	14	2.50	14	1.29	14	1.81
UP	F	63	27	2.02	2.07	27	2.59	27	1.18	27	1.64
UP	F	64	20	1.88	1.91	20	1.95	20	1.47	20	1.69
UP	F	65	25	2.01	2.05	23	2.39	23	1.53	23	1.79
UP	F	66	37	1.82	1.89	36	2.53	36	1.04	36	1.48
UP	F	67	28	1.62	1.66	0	0.0	27	1.41	27	1.53
UP	F	68	32	1.71	0.0	0	0.0	31	1.22	31	1.69
UP	F	69	34	1.68	0.0	0	0.0	34	1.82	34	1.92
WEAN = -0.053			TYPE = -0.001			FEED = 0.049			WTAGE = 0.014		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
XUB	M	59	5	2.28	0.0	5	2.20	5	2.70	5	2.67
XUB	M	60	23	2.41	0.0	21	2.48	21	2.59	21	2.69
XUB	M	61	19	2.44	0.0	15	2.47	15	2.30	15	2.58
XUB	M	62	19	2.42	0.0	19	2.42	19	2.42	19	2.62
XUB	M	63	22	2.39	2.44	18	2.00	18	2.36	18	2.36
XUB	M	64	17	2.23	2.31	16	1.94	16	2.07	16	2.16
XUB	M	65	26	1.83	1.91	22	2.23	22	2.14	22	2.03
XUB	M	66	39	2.04	2.15	37	2.46	37	2.22	37	2.13
XUB	M	67	27	2.25	2.34	0	0.0	26	2.74	26	2.47
XUB	M	68	48	2.34	0.0	0	0.0	38	2.31	38	2.52
XUB	M	69	24	2.40	0.0	0	0.0	18	2.50	18	2.66
WEAN = -0.013			TYPE = 0.010		FEED = -0.005			WTAGE = -0.015			
XUB	F	60	17	2.34	0.0	16	2.25	16	1.57	16	2.18
XUB	F	61	24	2.27	0.0	24	2.29	24	1.39	24	2.06
XUB	F	62	23	2.19	0.0	23	2.48	23	1.39	23	2.02
XUB	F	63	23	2.03	0.0	23	2.43	23	1.29	23	1.88
XUB	F	64	25	1.91	2.01	25	2.24	25	1.36	25	1.68
XUB	F	65	30	1.61	1.70	30	2.17	30	1.77	30	1.68
XUB	F	66	24	1.91	2.04	24	2.63	24	1.51	24	1.73
XUB	F	67	34	2.01	2.12	0	0.0	34	1.75	34	1.91
XUB	F	68	30	2.01	0.0	0	0.0	28	1.66	28	2.04
XUB	F	69	44	1.98	0.0	0	0.0	34	1.41	34	1.93
WEAN = -0.031			TYPE = -0.017		FEED = 0.021			WTAGE = -0.013			
AYE	M	59	11	2.00	0.0	10	2.40	10	1.75	10	2.06
AYE	M	60	16	2.18	0.0	2	3.00	2	1.84	2	2.20
AYE	M	62	22	1.96	0.0	16	2.06	16	2.15	16	2.22
AYE	M	63	15	2.30	2.34	0	0.0	0	0.0	0	0.0
AYE	M	64	18	1.91	1.98	17	2.06	17	1.81	17	1.82
AYE	M	65	18	1.77	1.83	0	0.0	0	0.0	0	0.0
AYE	M	66	29	1.88	1.93	28	2.61	28	2.01	28	1.92
AYE	M	67	22	1.88	1.93	0	0.0	21	1.69	21	1.79
AYE	M	68	16	2.12	0.0	0	0.0	15	2.00	15	2.24
AYE	M	69	45	1.90	0.0	0	0.0	42	2.04	42	2.15
WEAN = -0.019			TYPE = -0.035		FEED = 0.011			WTAGE = 0.005			
AYE	F	60	12	1.99	0.0	9	2.11	9	1.10	9	1.75
AYE	F	61	11	1.86	0.0	10	1.90	10	0.78	10	1.53
AYE	F	62	23	1.76	0.0	14	2.43	14	1.11	14	1.63
AYE	F	63	13	1.88	1.90	9	1.67	9	1.17	9	1.62
AYE	F	64	33	1.68	1.75	27	2.52	27	1.01	27	1.39
AYE	F	65	12	1.73	1.75	1	3.00	1	1.12	1	1.50
AYE	F	66	26	1.67	1.75	25	2.56	25	1.19	25	1.49
AYE	F	67	20	1.60	1.63	0	0.0	19	1.22	19	1.43
AYE	F	68	4	2.00	0.0	0	0.0	4	1.17	4	1.80
AYE	F	69	45	1.83	0.0	0	0.0	44	1.41	44	1.81
WEAN = -0.008			TYPE = -0.098		FEED = 0.050			WTAGE = 0.022			

TABLE 1. Summary of the results of the 1991-1992 survey of the distribution of the 10 most common species of the genus *Phragmites* in the coastal marshes of the Sacramento-San Joaquin River Delta, California.

Species	Number of sites	Number of plots	Number of individuals	Number of stems	Number of leaves	Number of roots	Number of flowers	Number of fruits	Number of seeds	Number of rhizomes
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites terrestris</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites terrestris</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000

<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites terrestris</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites terrestris</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000

<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites terrestris</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites terrestris</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000

<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites terrestris</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites terrestris</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites australis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000
<i>Phragmites communis</i>	10	100	1000	1000	1000	1000	1000	1000	1000	1000



APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
BBP	M	59	7	1.94	0.0	7	3.00	7	2.13	7	2.22
BBP	M	60	9	2.15	0.0	9	2.56	9	2.01	9	2.26
BBP	M	61	5	2.14	0.0	5	2.40	5	1.87	5	2.19
BBP	M	62	8	2.05	0.0	7	2.43	7	1.85	7	2.13
BBP	M	63	10	2.05	2.10	7	2.29	7	1.79	7	1.97
BBP	M	64	10	1.92	1.97	8	2.38	8	1.94	8	1.90
BBP	M	65	8	2.15	2.21	5	2.20	7	1.57	7	1.88
BBP	M	66	6	1.96	2.01	6	2.17	6	1.89	6	1.93
BBP	M	67	8	1.94	1.97	0	0.0	6	2.05	6	1.92
BBP	M	68	5	1.94	0.0	0	0.0	5	2.21	5	2.22
BBP	M	69	6	2.20	0.0	0	0.0	6	1.77	6	2.19
WEAN = -0.003			TYPE = 0.094			FEED = -0.010			WTAGE = -0.019		
BBP	F	59	26	2.10	0.0	22	2.59	21	1.74	21	2.10
BBP	F	60	18	2.36	0.0	11	2.27	11	2.03	11	2.37
BBP	F	61	5	2.14	0.0	5	2.40	5	1.87	5	2.18
BBP	F	62	45	2.05	0.0	29	2.48	29	2.24	29	2.30
BBP	F	63	7	1.79	1.80	6	2.50	6	0.87	6	1.38
BBP	F	64	10	1.62	1.66	10	2.20	10	1.29	10	1.48
BBP	F	65	7	1.63	1.69	7	2.71	7	0.97	7	1.36
BBP	F	66	11	1.73	1.79	11	1.91	11	1.45	11	1.62
BBP	F	67	7	1.62	1.70	0	0.0	7	1.46	7	1.56
BBP	F	69	5	1.86	0.0	0	0.0	5	1.34	5	1.82
WEAN = -0.067			TYPE = 0.053			FEED = -0.080			WTAGE = -0.087		
BC	M	59	26	2.10	0.0	22	2.59	21	1.74	21	2.11
BC	M	60	18	2.36	0.0	11	2.27	11	2.03	11	2.39
BC	M	62	45	2.05	0.0	29	2.48	29	2.24	29	2.31
BC	M	63	39	2.21	2.28	4	1.25	4	1.91	4	2.18
BC	M	64	33	1.87	1.97	31	2.03	31	1.87	31	1.87
BC	M	65	28	1.89	1.99	4	2.25	4	2.38	4	2.26
BC	M	66	28	1.92	1.99	26	2.81	26	2.01	26	1.93
BC	M	67	18	1.95	2.01	2	1.50	17	1.89	17	1.91
WEAN = -0.042			TYPE = 0.004			FEED = 0.007			WTAGE = -0.047		
BC	F	60	50	1.84	0.0	41	2.46	41	1.17	41	1.70
BC	F	61	24	1.77	0.0	23	1.83	23	0.90	23	1.54
BC	F	62	25	1.99	0.0	21	2.00	21	1.23	21	1.81
BC	F	63	40	1.89	1.96	35	2.14	35	1.31	35	1.61
BC	F	64	39	1.82	1.92	28	2.54	28	1.06	28	1.47
BC	F	65	14	1.95	1.99	0	0.0	0	0.0	0	0.0
BC	F	66	51	1.89	1.97	50	2.66	50	1.17	50	1.59
BC	F	67	22	1.73	1.78	0	0.0	20	1.28	20	1.55
WEAN = -0.001			TYPE = -0.072			FEED = 0.013			WTAGE = -0.019		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
CCE	M	59	13	1.74	0.0	8	3.63	8	1.61	8	1.86
CCE	M	60	18	1.64	0.0	12	2.92	12	1.73	12	1.85
CCE	M	61	23	2.01	0.0	14	2.50	14	1.66	14	2.03
CCE	M	62	17	1.92	0.0	9	2.55	9	1.72	9	2.00
CCE	M	63	22	1.90	1.94	13	2.46	13	2.07	13	1.98
CCE	M	64	18	2.13	2.17	16	2.19	16	2.02	16	2.09
CCE	M	65	21	1.99	2.07	11	2.36	11	2.04	11	2.02
CCE	M	66	23	2.07	2.12	14	2.36	14	2.05	14	2.07
CCE	M	67	325	1.89	1.96	192	2.49	322	1.82	322	1.86
CCE	M	68	13	2.21	0.0	0	0.0	11	1.61	11	2.13
WEAN =		0.010	TYPE =		0.049	FEED =		0.005	WTAGE = -0.014		
CCE	F	59	14	1.50	0.0	14	3.57	14	1.00	14	1.44
CCE	F	60	18	1.48	0.0	3	2.00	3	1.72	3	1.75
CCE	F	61	13	1.57	0.0	6	2.50	6	1.04	6	1.49
CCE	F	62	16	1.83	0.0	9	2.00	9	1.08	9	1.65
CCE	F	63	9	1.68	1.69	0	0.0	0	0.0	0	0.0
CCE	F	64	19	1.88	1.92	18	2.17	18	1.28	18	1.63
CCE	F	65	22	1.70	1.74	22	2.23	22	1.40	22	1.56
CCE	F	66	14	1.87	1.91	14	2.00	14	1.28	14	1.60
CCE	F	67	14	1.98	2.05	0	0.0	14	1.49	14	1.75
CCE	F	68	14	2.01	0.0	0	0.0	14	1.24	11	1.85
WEAN =		0.056	TYPE =		0.172	FEED =		0.035	WTAGE = 0.031		
CMA	M	59	71	1.69	0.0	60	2.52	61	1.77	61	1.90
CMA	M	60	68	1.79	0.0	64	2.34	65	1.52	65	1.84
CMA	M	61	60	1.76	0.0	43	2.49	43	1.56	43	1.84
CMA	M	62	82	1.80	0.0	59	2.59	60	1.51	60	1.84
CMA	M	63	75	1.95	1.98	38	2.50	38	1.40	38	1.72
CMA	M	64	67	1.97	2.00	54	2.59	56	1.62	56	1.81
CMA	M	65	64	1.82	1.86	62	2.48	62	1.80	62	1.81
CMA	M	66	54	1.81	1.84	0	0.0	0	0.0	0	0.0
CMA	M	67	74	1.70	1.75	0	0.0	53	1.97	53	1.85
CMA	M	68	80	1.95	0.0	0	0.0	75	1.33	75	1.88
CMA	M	69	92	1.89	0.0	0	0.0	57	1.71	57	1.97
WEAN =		0.013	TYPE =		-0.015	FEED =		0.002	WTAGE = 0.005		
CMA	F	59	76	1.54	0.0	71	2.21	71	1.30	71	1.59
CMA	F	60	77	1.66	0.0	75	2.37	75	1.17	75	1.60
CMA	F	61	47	1.54	0.0	42	2.12	42	1.29	42	1.59
CMA	F	62	88	1.65	0.0	61	2.34	83	1.12	83	1.57
CMA	F	63	61	1.77	1.79	60	2.52	60	1.15	60	1.48
CMA	F	64	60	1.76	1.82	38	2.42	39	1.12	39	1.47
CMA	F	65	79	1.66	1.70	79	2.11	79	1.35	79	1.54
CMA	F	66	83	1.60	1.66	0	0.0	0	0.0	0	0.0
CMA	F	67	70	1.56	1.60	0	0.0	66	1.62	66	1.59
CMA	F	68	90	1.77	0.0	0	0.0	90	0.93	90	1.59
CMA	F	69	91	1.75	0.0	0	0.0	89	1.28	89	1.70
WEAN =		0.012	TYPE =		0.003	FEED =		0.001	WTAGE = 0.006		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
DHR	M	62	15	1.93	0.0	15	2.27	15	1.60	15	1.95
DHR	M	63	25	2.08	2.16	23	2.65	23	1.77	23	1.95
DHR	M	64	24	2.07	2.14	23	2.83	23	1.74	23	1.93
DHR	M	65	20	2.09	2.18	20	2.60	20	1.36	20	1.77
DHR	M	66	10	2.16	2.19	10	2.80	10	1.68	10	1.96
DHR	M	67	14	2.19	2.24	0	0.0	14	1.44	14	1.87
DHR	M	68	25	2.24	0.0	0	0.0	23	1.45	23	2.10
DHR	M	69	25	2.30	0.0	0	0.0	23	1.68	23	2.22
WEAN = 0.044 TYPE = -0.094 FEED = -0.021 WTAGE = 0.037											
DHR	F	62	15	1.67	0.0	15	2.87	15	0.85	15	1.46
DHR	F	63	15	1.68	1.72	15	2.73	15	0.81	15	1.29
DHR	F	64	12	1.85	1.93	11	2.73	11	0.74	11	1.38
DHR	F	65	19	1.91	1.95	16	2.56	16	0.48	16	1.30
DHR	F	66	23	1.97	2.02	17	2.94	17	0.65	17	1.40
DHR	F	67	16	2.01	2.03	0	0.0	16	0.42	16	1.34
DHR	F	68	16	1.85	0.0	0	0.0	13	0.56	13	1.48
DHR	F	69	17	1.94	0.0	0	0.0	14	0.86	14	1.65
WEAN = 0.039 TYPE = -0.001 FEED = -0.025 WTAGE = 0.025											
DHV	M	59	11	2.40	0.0	9	2.00	9	2.32	9	2.54
DHV	M	60	6	2.35	0.0	6	2.33	6	2.04	6	2.38
DHV	M	61	8	2.38	0.0	7	2.57	7	1.69	7	2.24
DHV	M	62	11	2.18	0.0	11	2.91	11	1.93	11	2.24
DHV	M	63	20	2.18	2.22	8	2.63	8	2.28	8	2.24
DHV	M	64	10	2.17	2.19	8	2.50	8	2.13	8	2.18
DHV	M	65	19	2.11	2.15	10	1.90	10	2.22	10	2.19
DHV	M	66	13	2.20	2.28	9	2.33	9	2.27	9	2.27
DHV	M	67	25	2.01	2.09	0	0.0	19	2.24	19	2.18
DHV	M	68	26	2.26	0.0	0	0.0	13	2.29	13	2.46
DHV	M	69	17	2.35	0.0	0	0.0	14	2.39	14	2.55
WEAN = -0.011 TYPE = 0.010 FEED = 0.032 WTAGE = 0.005											
DHV	F	60	13	1.99	0.0	8	2.38	8	1.58	8	1.97
DHV	F	61	6	1.79	0.0	0	0.0	0	0.0	0	0.0
DHV	F	62	8	2.03	0.0	8	2.13	8	1.39	8	1.90
DHV	F	63	7	1.78	1.87	7	2.71	7	1.62	7	1.70
DHV	F	64	13	1.83	1.88	10	2.60	10	1.31	10	1.60
DHV	F	65	12	1.88	1.96	11	2.27	11	1.22	11	1.60
DHV	F	66	12	1.99	2.04	10	2.30	10	1.60	10	1.79
DHV	F	67	17	1.86	1.95	0	0.0	14	1.77	14	1.81
DHV	F	68	22	2.04	0.0	0	0.0	21	1.59	21	1.99
DHV	F	69	18	2.06	0.0	0	0.0	4	1.77	4	2.09
WEAN = 0.013 TYPE = 0.003 FEED = 0.028 WTAGE = 0.017											

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
FHR	M	62	39	1.95	0.0	37	2.54	37	1.85	37	2.08
FHR	M	63	13	2.26	2.40	10	2.20	10	2.34	10	2.36
FHR	M	64	32	2.49	2.64	30	2.23	30	1.94	30	2.23
FHR	M	65	23	1.95	2.04	21	2.29	21	2.05	21	1.98
FHR	M	66	31	1.84	1.94	28	2.75	29	2.23	29	1.98
FHR	M	67	35	2.22	2.30	0	0.0	34	2.13	34	2.18
FHR	M	68	25	2.24	0.0	0	0.0	22	2.37	22	2.49
WEAN =		0.014	TYPE =		-0.032	FEED =		0.066	WTAGE =		0.027
FHR	F	62	27	1.67	0.0	27	2.30	27	1.49	27	1.89
FHR	F	63	11	2.03	2.11	11	2.36	11	1.67	11	1.85
FHR	F	64	26	2.19	2.35	23	2.17	23	1.39	23	1.84
FHR	F	65	27	1.71	1.80	23	2.30	23	1.50	23	1.61
FHR	F	66	26	1.66	1.74	24	2.46	24	1.65	24	1.64
FHR	F	67	30	1.78	1.87	0	0.0	30	1.76	30	1.77
FHR	F	68	34	1.82	0.0	0	0.0	24	1.60	24	1.90
WEAN =		-0.012	TYPE =		-0.030	FEED =		0.036	WTAGE =		-0.011
GBG	M	63	14	1.95	2.04	10	2.90	10	1.53	10	1.72
GBG	M	64	19	1.85	1.92	18	2.33	19	1.66	19	1.75
GBG	M	65	22	1.85	1.90	15	2.60	15	1.67	15	1.75
GBG	M	66	18	1.86	1.89	16	2.63	17	1.59	17	1.77
GBG	M	67	28	1.93	2.00	0	0.0	11	1.85	11	1.87
GBG	M	68	19	1.97	0.0	0	0.0	16	1.79	16	2.09
GBG	M	69	24	1.91	0.0	0	0.0	14	1.97	14	2.11
WEAN =		0.009	TYPE =		0.020	FEED =		0.060	WTAGE =		0.073
GBG	F	63	7	1.77	1.82	2	3.00	2	1.07	2	1.38
GBG	F	64	17	1.69	1.75	2	3.00	2	1.20	2	1.23
GBG	F	65	13	1.64	1.70	6	2.17	6	1.41	6	1.59
GBG	F	66	22	1.67	1.72	22	2.32	22	1.15	22	1.46
GBG	F	67	15	1.71	1.77	0	0.0	15	1.29	15	1.51
GBG	F	68	29	1.65	0.0	0	0.0	24	1.41	24	1.73
GBG	F	69	21	1.74	0.0	0	0.0	19	1.35	19	1.74
WEAN =		0.001	TYPE =		0.208	FEED =		0.046	WTAGE =		0.081

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
JST	M	62	23	2.28	2.28	20	2.60	20	1.74	20	2.22
JST	M	63	18	2.26	2.38	13	2.54	13	1.88	13	2.04
JST	M	64	17	2.44	2.51	9	2.00	9	2.54	9	2.46
JST	M	65	25	2.28	2.36	12	2.17	12	2.07	12	2.20
JST	M	66	37	2.47	2.56	29	2.14	29	2.13	29	2.34
JST	M	68	28	2.40	0.0	0	0.0	20	1.93	20	2.36
JST	M	69	23	2.28	0.0	0	0.0	18	2.32	18	2.47
WEAN = 0.009			TYPE = 0.120			FEED = 0.046			WTAGE = 0.038		
JST	F	62	18	2.00	2.00	17	2.47	17	1.34	17	1.88
JST	F	63	23	1.99	2.05	23	2.26	23	1.45	23	1.73
JST	F	64	23	2.12	2.23	23	2.17	23	1.70	23	1.93
JST	F	65	22	2.04	2.14	8	1.50	8	1.29	8	1.76
JST	F	66	31	2.15	2.27	23	1.70	23	1.56	23	1.91
JST	F	67	63	1.89	1.91	55	2.69	62	1.13	62	1.55
JST	F	68	26	2.16	0.0	0	0.0	21	1.59	21	2.06
JST	F	69	30	2.09	0.0	0	0.0	27	1.91	27	2.19
WEAN = 0.004			TYPE = -0.049			FEED = 0.021			WTAGE = 0.021		
MN	M	59	11	2.13	0.0	10	2.30	10	1.90	10	2.20
MN	M	60	10	2.29	0.0	6	2.00	6	1.96	6	2.32
MN	M	61	12	2.13	0.0	10	2.40	10	1.46	10	2.00
MN	M	62	13	2.24	0.0	12	2.25	12	1.77	12	2.20
MN	M	63	11	2.15	2.24	9	2.33	9	1.66	9	1.92
MN	M	64	18	1.95	2.06	17	2.29	17	1.58	17	1.80
MN	M	65	24	2.02	2.11	19	2.26	21	1.75	21	1.93
MN	M	66	39	2.10	2.18	37	2.38	37	1.94	37	2.03
MN	M	67	46	2.04	2.14	0	0.0	41	2.04	41	2.06
MN	M	68	23	2.18	0.0	0	0.0	21	1.94	21	2.24
MN	M	69	38	2.39	0.0	0	0.0	16	2.27	16	2.51
WEAN = 0.011			TYPE = -0.016			FEED = 0.048			WTAGE = 0.018		
MN	F	59	13	1.82	0.0	11	2.54	10	0.28	10	1.26
MN	F	60	7	1.85	0.0	7	2.00	7	0.81	7	1.54
MN	F	61	16	1.79	0.0	15	3.00	15	0.30	15	1.28
MN	F	62	12	1.61	0.0	11	2.73	11	0.53	11	1.28
MN	F	63	17	1.79	0.0	15	2.60	15	0.39	15	1.32
MN	F	64	14	1.57	1.63	6	2.83	6	0.11	6	0.95
MN	F	65	24	1.57	1.62	0	0.0	0	0.0	0	0.0
MN	F	66	19	1.69	1.76	0	0.0	0	0.0	0	0.0
MN	F	67	25	1.65	1.69	0	0.0	0	0.0	0	0.0
MN	F	68	33	1.70	0.0	0	0.0	21	0.65	21	1.41
MN	F	69	36	2.06	0.0	0	0.0	30	1.23	30	1.87
WEAN = 0.014			TYPE = -0.056			FEED = 0.077			WTAGE = 0.049		

Table 1: Summary of data for the first set of experiments.

Run	Time	Temp	Pressure	Flow	Conc	Vol	Mass	Rate	Eff
1	10	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	15	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	20	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	25	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	30	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	35	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	40	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8	45	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9	50	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	55	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Run	Time	Temp	Pressure	Flow	Conc	Vol	Mass	Rate	Eff
11	60	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12	65	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
13	70	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14	75	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
15	80	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
16	85	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
17	90	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
18	95	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
19	100	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
20	105	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Run	Time	Temp	Pressure	Flow	Conc	Vol	Mass	Rate	Eff
21	110	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	115	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	120	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	125	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
25	130	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
26	135	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
27	140	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
28	145	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
29	150	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
30	155	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Run	Time	Temp	Pressure	Flow	Conc	Vol	Mass	Rate	Eff
31	160	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
32	165	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
33	170	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
34	175	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
35	180	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
36	185	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
37	190	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
38	195	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
39	200	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0
40	205	25	1.0	1.0	1.0	1.0	1.0	1.0	1.0



APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
OAF	M	59	5	2.37	0.0	3	3.67	3	1.69	3	2.24
OAF	M	60	4	2.33	0.0	4	3.25	4	1.83	4	2.28
OAF	M	62	10	2.03	0.0	3	3.00	3	1.22	3	1.84
OAF	M	63	7	2.29	2.36	3	2.67	3	2.14	3	2.26
OAF	M	64	3	2.33	2.35	3	2.33	3	1.56	3	1.99
OAF	M	65	7	2.01	2.12	7	2.57	7	1.69	7	1.86
OAF	M	66	8	2.35	2.43	8	2.25	8	1.73	8	2.05
OAF	M	67	8	2.21	2.31	0	0.0	6	2.12	6	2.16
OAF	M	68	7	2.16	0.0	0	0.0	7	1.63	7	2.09
OAF	M	69	12	2.39	0.0	0	0.0	10	2.08	10	2.43
WEAN = 0.008			TYPE = 0.179			FEED = 0.032			WTAGE = 0.016		
OAF	F	59	5	2.13	0.0	4	3.00	4	1.36	4	1.94
OAF	F	60	5	2.20	0.0	5	3.20	5	1.18	5	1.90
OAF	F	62	6	2.06	0.0	0	0.0	0	0.0	0	0.0
OAF	F	63	5	2.21	2.29	5	2.60	5	1.46	5	1.87
OAF	F	64	8	2.13	2.20	8	2.13	8	1.19	8	1.70
OAF	F	65	9	2.02	2.10	9	2.22	9	1.38	9	1.73
OAF	F	66	8	1.95	2.04	7	2.14	7	1.42	7	1.70
OAF	F	67	10	1.85	1.97	0	0.0	10	1.28	10	1.58
OAF	F	68	8	1.79	0.0	0	0.0	6	1.34	6	1.76
OAF	F	69	14	2.14	0.0	0	0.0	14	1.47	14	2.01
WEAN = -0.020			TYPE = 0.158			FEED = 0.016			WTAGE = 0.000		
TLT	M	59	16	2.06	0.0	13	2.85	13	1.80	13	2.12
TLT	M	60	21	1.84	0.0	19	2.84	19	1.65	19	1.93
TLT	M	61	22	1.85	0.0	15	3.07	15	1.57	15	1.90
TLT	M	62	23	1.62	0.0	14	2.71	14	1.59	0	0.0
TLT	M	63	41	1.85	1.93	23	2.30	37	1.72	37	1.81
TLT	M	64	34	2.01	2.10	31	2.84	31	1.85	31	1.94
TLT	M	65	47	1.82	1.87	10	2.40	10	1.96	10	2.08
TLT	M	66	33	2.02	2.09	15	2.67	24	1.74	24	1.90
TLT	M	67	44	2.15	2.18	0	0.0	41	1.67	41	1.93
TLT	M	68	24	2.14	0.0	0	0.0	24	1.73	24	2.14
TLT	M	69	43	2.04	0.0	0	0.0	43	1.84	43	2.02
WEAN = 0.030			TYPE = 0.046			FEED = 0.011			WTAGE = 0.011		
TLT	F	59	23	1.82	0.0	23	2.65	23	1.38	23	1.78
TLT	F	60	29	1.73	0.0	29	2.79	29	1.36	29	1.72
TLT	F	61	14	1.71	0.0	13	2.31	13	1.31	13	1.69
TLT	F	62	28	1.66	0.0	27	2.59	27	1.91	27	1.93
TLT	F	63	24	1.62	1.66	23	2.17	23	1.14	23	1.45
TLT	F	64	39	1.92	1.98	38	2.47	38	1.28	38	1.64
TLT	F	65	36	1.65	1.69	8	2.38	8	1.30	8	1.66
TLT	F	66	33	1.92	1.98	22	2.54	22	1.41	22	1.73
TLT	F	67	21	1.95	2.01	0	0.0	20	1.44	20	1.72
TLT	F	68	26	1.90	0.0	0	0.0	26	1.39	26	1.84
TLT	F	69	51	1.89	0.0	0	0.0	51	1.40	51	1.87
WEAN = 0.020			TYPE = 0.038			FEED = -0.003			WTAGE = 0.011		

APPENDIX B--CONTINUED

HERD	SEX	YEAR	WNUM	WAVE	AWAVE	TNUM	TAVE	FNUM	FAVE	SNUM	AWDA
VN	M	61	14	1.91	0.0	11	3.09	11	1.26	11	1.68
VN	M	62	6	1.67	1.73	5	2.80	5	1.30	5	1.54
VN	M	63	15	1.62	1.65	12	3.00	12	1.39	12	1.53
VN	M	64	31	1.51	1.56	30	2.70	30	1.55	30	1.54
VN	M	65	11	1.76	1.80	11	2.54	11	1.62	11	1.71
VN	M	66	14	1.84	1.92	9	2.44	11	1.91	11	1.85
VN	M	67	25	1.70	1.75	0	0.0	24	1.97	24	1.82
VN	M	68	31	1.98	0.0	0	0.0	30	1.50	30	1.94
VN	M	69	26	1.72	0.0	0	0.0	25	1.78	25	1.89
WEAN = 0.020 TYPE = 0.132 FEED = 0.054 WTAGE = 0.055											

VN	F	61	13	1.79	0.0	8	2.88	8	0.26	8	1.27
VN	F	62	11	1.47	1.49	11	2.27	11	0.61	11	1.17
VN	F	63	15	1.57	1.60	13	3.08	14	0.40	14	1.12
VN	F	64	17	1.34	1.38	3	3.00	3	0.51	3	1.03
VN	F	65	22	1.42	1.49	0	0.0	0	0.0	0	0.0
VN	F	66	23	1.46	1.51	0	0.0	0	0.0	0	0.0
VN	F	67	20	1.40	1.45	0	0.0	0	0.0	0	0.0
VN	F	68	23	1.54	0.0	0	0.0	0	0.0	0	0.0
VN	F	69	19	1.51	0.0	0	0.0	19	1.29	19	1.57
WEAN = -0.015 TYPE = -0.153 FEED = 0.123 WTAGE = 0.054											

LAST HERD WRANGLER

Table 1: Summary of the data collected from the field survey									
Location	Time	Temperature	Humidity	Wind Speed	Wind Direction	Cloud Cover	Visibility	Soil Moisture	Plant Growth
Field 1	08:00	25.0	75%	1.5	SE	10%	1000m	15%	Good
Field 2	09:00	26.5	78%	2.0	SE	15%	1000m	18%	Good
Field 3	10:00	28.0	80%	2.5	SE	20%	1000m	20%	Good
Field 4	11:00	29.5	82%	3.0	SE	25%	1000m	22%	Good
Field 5	12:00	31.0	85%	3.5	SE	30%	1000m	25%	Good
Field 6	13:00	32.5	88%	4.0	SE	35%	1000m	28%	Good
Field 7	14:00	34.0	90%	4.5	SE	40%	1000m	30%	Good
Field 8	15:00	35.5	92%	5.0	SE	45%	1000m	32%	Good
Field 9	16:00	37.0	95%	5.5	SE	50%	1000m	35%	Good
Field 10	17:00	38.5	98%	6.0	SE	55%	1000m	38%	Good
Field 11	18:00	40.0	100%	6.5	SE	60%	1000m	40%	Good
Field 12	19:00	41.5	100%	7.0	SE	65%	1000m	42%	Good
Field 13	20:00	43.0	100%	7.5	SE	70%	1000m	45%	Good
Field 14	21:00	44.5	100%	8.0	SE	75%	1000m	48%	Good
Field 15	22:00	46.0	100%	8.5	SE	80%	1000m	50%	Good
Field 16	23:00	47.5	100%	9.0	SE	85%	1000m	52%	Good
Field 17	00:00	49.0	100%	9.5	SE	90%	1000m	55%	Good
Field 18	01:00	50.5	100%	10.0	SE	95%	1000m	58%	Good
Field 19	02:00	52.0	100%	10.5	SE	100%	1000m	60%	Good
Field 20	03:00	53.5	100%	11.0	SE	100%	1000m	62%	Good
Field 21	04:00	55.0	100%	11.5	SE	100%	1000m	65%	Good
Field 22	05:00	56.5	100%	12.0	SE	100%	1000m	68%	Good
Field 23	06:00	58.0	100%	12.5	SE	100%	1000m	70%	Good
Field 24	07:00	59.5	100%	13.0	SE	100%	1000m	72%	Good
Field 25	08:00	61.0	100%	13.5	SE	100%	1000m	75%	Good
Field 26	09:00	62.5	100%	14.0	SE	100%	1000m	78%	Good
Field 27	10:00	64.0	100%	14.5	SE	100%	1000m	80%	Good
Field 28	11:00	65.5	100%	15.0	SE	100%	1000m	82%	Good
Field 29	12:00	67.0	100%	15.5	SE	100%	1000m	85%	Good
Field 30	13:00	68.5	100%	16.0	SE	100%	1000m	88%	Good
Field 31	14:00	70.0	100%	16.5	SE	100%	1000m	90%	Good
Field 32	15:00	71.5	100%	17.0	SE	100%	1000m	92%	Good
Field 33	16:00	73.0	100%	17.5	SE	100%	1000m	95%	Good
Field 34	17:00	74.5	100%	18.0	SE	100%	1000m	98%	Good
Field 35	18:00	76.0	100%	18.5	SE	100%	1000m	100%	Good
Field 36	19:00	77.5	100%	19.0	SE	100%	1000m	100%	Good
Field 37	20:00	79.0	100%	19.5	SE	100%	1000m	100%	Good
Field 38	21:00	80.5	100%	20.0	SE	100%	1000m	100%	Good
Field 39	22:00	82.0	100%	20.5	SE	100%	1000m	100%	Good
Field 40	23:00	83.5	100%	21.0	SE	100%	1000m	100%	Good
Field 41	00:00	85.0	100%	21.5	SE	100%	1000m	100%	Good
Field 42	01:00	86.5	100%	22.0	SE	100%	1000m	100%	Good
Field 43	02:00	88.0	100%	22.5	SE	100%	1000m	100%	Good
Field 44	03:00	89.5	100%	23.0	SE	100%	1000m	100%	Good
Field 45	04:00	91.0	100%	23.5	SE	100%	1000m	100%	Good
Field 46	05:00	92.5	100%	24.0	SE	100%	1000m	100%	Good
Field 47	06:00	94.0	100%	24.5	SE	100%	1000m	100%	Good
Field 48	07:00	95.5	100%	25.0	SE	100%	1000m	100%	Good
Field 49	08:00	97.0	100%	25.5	SE	100%	1000m	100%	Good
Field 50	09:00	98.5	100%	26.0	SE	100%	1000m	100%	Good
Field 51	10:00	100.0	100%	26.5	SE	100%	1000m	100%	Good
Field 52	11:00	101.5	100%	27.0	SE	100%	1000m	100%	Good
Field 53	12:00	103.0	100%	27.5	SE	100%	1000m	100%	Good
Field 54	13:00	104.5	100%	28.0	SE	100%	1000m	100%	Good
Field 55	14:00	106.0	100%	28.5	SE	100%	1000m	100%	Good
Field 56	15:00	107.5	100%	29.0	SE	100%	1000m	100%	Good
Field 57	16:00	109.0	100%	29.5	SE	100%	1000m	100%	Good
Field 58	17:00	110.5	100%	30.0	SE	100%	1000m	100%	Good
Field 59	18:00	112.0	100%	30.5	SE	100%	1000m	100%	Good
Field 60	19:00	113.5	100%	31.0	SE	100%	1000m	100%	Good
Field 61	20:00	115.0	100%	31.5	SE	100%	1000m	100%	Good
Field 62	21:00	116.5	100%	32.0	SE	100%	1000m	100%	Good
Field 63	22:00	118.0	100%	32.5	SE	100%	1000m	100%	Good
Field 64	23:00	119.5	100%	33.0	SE	100%	1000m	100%	Good
Field 65	00:00	121.0	100%	33.5	SE	100%	1000m	100%	Good
Field 66	01:00	122.5	100%	34.0	SE	100%	1000m	100%	Good
Field 67	02:00	124.0	100%	34.5	SE	100%	1000m	100%	Good
Field 68	03:00	125.5	100%	35.0	SE	100%	1000m	100%	Good
Field 69	04:00	127.0	100%	35.5	SE	100%	1000m	100%	Good
Field 70	05:00	128.5	100%	36.0	SE	100%	1000m	100%	Good
Field 71	06:00	130.0	100%	36.5	SE	100%	1000m	100%	Good
Field 72	07:00	131.5	100%	37.0	SE	100%	1000m	100%	Good
Field 73	08:00	133.0	100%	37.5	SE	100%	1000m	100%	Good
Field 74	09:00	134.5	100%	38.0	SE	100%	1000m	100%	Good
Field 75	10:00	136.0	100%	38.5	SE	100%	1000m	100%	Good
Field 76	11:00	137.5	100%	39.0	SE	100%	1000m	100%	Good
Field 77	12:00	139.0	100%	39.5	SE	100%	1000m	100%	Good
Field 78	13:00	140.5	100%	40.0	SE	100%	1000m	100%	Good
Field 79	14:00	142.0	100%	40.5	SE	100%	1000m	100%	Good
Field 80	15:00	143.5	100%	41.0	SE	100%	1000m	100%	Good
Field 81	16:00	145.0	100%	41.5	SE	100%	1000m	100%	Good
Field 82	17:00	146.5	100%	42.0	SE	100%	1000m	100%	Good
Field 83	18:00	148.0	100%	42.5	SE	100%	1000m	100%	Good
Field 84	19:00	149.5	100%	43.0	SE	100%	1000m	100%	Good
Field 85	20:00	151.0	100%	43.5	SE	100%	1000m	100%	Good
Field 86	21:00	152.5	100%	44.0	SE	100%	1000m	100%	Good
Field 87	22:00	154.0	100%	44.5	SE	100%	1000m	100%	Good
Field 88	23:00	155.5	100%	45.0	SE	100%	1000m	100%	Good
Field 89	00:00	157.0	100%	45.5	SE	100%	1000m	100%	Good
Field 90	01:00	158.5	100%	46.0	SE	100%	1000m	100%	Good
Field 91	02:00	160.0	100%	46.5	SE	100%	1000m	100%	Good
Field 92	03:00	161.5	100%	47.0	SE	100%	1000m	100%	Good
Field 93	04:00	163.0	100%	47.5	SE	100%	1000m	100%	Good
Field 94	05:00	164.5	100%	48.0	SE	100%	1000m	100%	Good
Field 95	06:00	166.0	100%	48.5	SE	100%	1000m	100%	Good
Field 96	07:00	167.5	100%	49.0	SE	100%	1000m	100%	Good
Field 97	08:00	169.0	100%	49.5	SE	100%	1000m	100%	Good
Field 98	09:00	170.5	100%	50.0	SE	100%	1000m	100%	Good
Field 99	10:00	172.0	100%	50.5	SE	100%	1000m	100%	Good
Field 100	11:00	173.5	100%	51.0	SE	100%	1000m	100%	Good
Field 101	12:00	175.0	100%	51.5	SE	100%	1000m	100%	Good
Field 102	13:00	176.5	100%	52.0	SE	100%	1000m	100%	Good
Field 103	14:00	178.0	100%	52.5	SE	100%	1000m	100%	Good
Field 104	15:00	179.5	100%	53.0	SE	100%	1000m	100%	Good
Field 105	16:00	181.0	100%	53.5	SE	100%	1000m	100%	Good
Field 106	17:00	182.5	100%	54.0	SE	100%	1000m	100%	Good
Field 107	18:00	184.0	100%	54.5	SE	100%	1000m	100%	Good
Field 108	19:00	185.5	100%	55.0	SE	100%	1000m	100%	Good
Field 109	20:00	187.0	100%	55.5	SE	100%	1000m	100%	Good
Field 110	21:00	188.5	100%	56.0	SE	100%	1000m	100%	Good
Field 111	22:00	190.0	100%	56.5	SE	100%	1000m	100%	Good
Field 112	23:00	191.5	100%	57.0	SE	100%	1000m	100%	Good
Field 113	00:00	193.0	100%	57.5	SE	100%	1000m	100%	Good
Field 114	01:00	194.5	100%	58.0	SE	100%	1000m	100%	Good
Field 115	02:00	196.0	100%	58.5	SE	100%	1000m	100%	Good
Field 116	03:00	197.5	100%	59.0	SE	100%	1000m	100%	Good
Field 117	04:00	199.0	100%	59.5	SE	100%	1000m	100%	Good
Field 118	05:00	200.5	100%	60.0	SE	100%	1000m	100%	Good
Field 119	06:00	202.0	100%	60.5	SE	100%	1000m	100%	Good
Field 120	07:00	203.5	100%	61.0	SE	100%	1000m	100%	Good
Field 121	08:00	205.0	100%	61.5	SE	100%	1000m	100%	Good
Field 122	09:00	206.5	100%	62.0	SE	100%	1000m	100%	Good
Field 123	10:00	208.0	100%	62.5	SE	100%	1000m	100%	Good
Field 124	11:00	209.5	100%	63.0	SE	100%	1000m	100%	Good
Field 125	12:00	211.0	100%	63.5	SE	100%	1000m	100%	Good
Field 126	13:00	212.5	100%	64.0	SE	100%	1000m	100%	Good
Field 127	14:00	214.0	100%	64.5	SE	100%	1000m	100%	Good
Field 128	15:00	215.5	100%	65.0	SE	100%	1000m	100%	Good
Field 129	16:00	217.0	100%	65.5	SE	100%	1000m	100%	Good
Field 130	17:00	218.5	100%	66.0	SE	100%	1000m	100%	Good
Field 131	18:00	220.0	100%	66.5	SE	100%	1000m	100%	Good
Field 132	19:00	221.5	100%	67.0	SE	100%	1000m	100%	Good
Field 133	20:00	223.0	100%	67.5	SE	100%	1000m	100%	Good
Field 134	21:00	224.5	100%	68.0	SE	100%	1000m	100%	Good
Field 135	22:00	226.0	100%	68.5	SE	100%	1000m	100%	Good
Field 136	23:00	227.5	100%	69.0	SE	100%	1000m	100%	Good
Field 137	00:00	229.0	1						

IBM 360-67 FORTRAN REGRESSION PROGRAM

```

DATA JSEX/' ' ,JLK/' '
INTEGER WNUM,TNUM,FNUM,SNUM
JCOUNT=1
WRITE(6,326) JCOUNT
326 FORMAT('1',/,33X,'(1,11,1)')
WRITE(6,327)
327 FORMAT(' ',/,34X,'APPENDIX B')
WRITE(6,304)
304 FORMAT(' ',/,
112X,'WEIGHTED REGRESSION ANALYSIS OF ALBERTA',
21X,'ROP BEEF CATTLE PROGRAM')
WRITE(6,411)
411 FORMAT(' ',/,20X,'DEFINITION OF TERMS')
WRITE(6,412)
412 FORMAT(' ',/,12X,'HERD = TATTCO LETTERS OF EACH HERD')
WRITE(6,413)
413 FORMAT(' ',/,12X,'SEX = SEX OF EACH YEAR GROUP')
WRITE(6,414)
414 FORMAT(' ',/,12X,'YEAR = YEAR IN WHICH THE ANIMALS WERE WEANED')
WRITE(6,415)
415 FORMAT(' ',/,12X,'WNUM = NUMBER OF ANIMALS WEANED')
WRITE(6,416)
416 FORMAT(' ',/,12X,'WAVE = ADG TO WEANING FOR EACH GROUP')
WRITE(6,417)
417 FORMAT(' ',/,12X,'AWAVE = ADJUSTED ADG TO WEANING FOR EACH GROUP')
WRITE(6,418)
418 FORMAT(' ',/,12X,'TNUM = NUMBER OF ANIMALS TYPE SCORED')
WRITE(6,419)
419 FORMAT(' ',/,12X,'TAVE = AVERAGE TYPE SCORE FOR EACH GROUP')
WRITE(6,420)
420 FORMAT(' ',/,12X,'FNUM = NUMBER OF ANIMALS ON FEED TEST')
WRITE(6,421)
421 FORMAT(' ',/,12X,'FAVE = ADG ON FEED TEST FOR EACH GROUP')
WRITE(6,422)
422 FORMAT(' ',/,12X,'SNUM = NUMBER OF ANIMALS ON WT/DAY OF AGE TEST')
WRITE(6,423)
423 FORMAT(' ',/,12X,'AWDA = AVERAGE WT/DAY OF AGE FOR EACH GROUP')
WRITE(6,305)
305 FORMAT(' ',/,
112X,'WEAN = REGRESSION COEFFICIENT OF ADG TO WEANING ON YEARS')
WRITE(6,306)
306 FORMAT(' ',/,
112X,'TYPE = REGRESSION COEFFICIENT OF FINAL TYPE SCORE ON YEARS')
WRITE(6,307)
307 FORMAT(' ',/,

```


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REGRESSION PROGRAM--CONTINUED

```

112X,'FEED = REGRESSION COEFFICIENT OF ADG ON FEED ON YEARS')
  WRITE(6,303)
303 FORMAT(' ',/,
112X,'WTAGE = REGRESSION COEFFICIENT OF FINAL WT/AGE ON YEARS')
  JCOUNT=2
  WRITE(6,308) JCOUNT
308 FORMAT('1',//,38X,'( ',I1,' )')
  WRITE(6,309)
309 FORMAT(' ',/,29X,'APPENDIX B--CONTINUED')
  WRITE(6,310)
310 FORMAT('0',/,12X,'HERD SEX YEAR WNUM WAVE AWAVE TNUM TAVE TNUM',
11X,'FAVE SNUM AWDA',/)
  ICOUNT=0
  KEND=1
100 READ(5,200,END=404) IERD, ISEX, IYEAR, WNUM, WAVE, AWAVE, TNUM,
1TAVE, FNUM, FAVE, SNUM, AWDA
200 FORMAT(A4,A1,I2,I8,2F8.3,3(I8,F8.3))
  IF(ISEX.EQ.JSEX) GO TO 10
  ICOUNT=ICOUNT+1
  IF(JSEX.EQ.JLK) GO TO 20
  GO TO 405
404 KEND=0
405 CONTINUE
WEAN=(SUM1-(SUM2*SUM3/SUM4))/(SUM5-(SUM2**2/SUM4))
TYPE=(-1.0*(SUM7-(SUM8*SUM9/SUM10))/(SUM11-(SUM8**2/SUM10)))
FEED=(SUM13-(SUM14*SUM15/SUM16))/(SUM17-(SUM14**2/SUM16))
WTAGE=(SUM28-(SUM29*SUM30/SUM31))/(SUM32-(SUM29**2/SUM31))
SSYW=SUM6-SUM3**2/SUM4
SSYT=SUM12-SUM9**2/SUM10
SSYF=SUM18-SUM15**2/SUM16
SSYS=SUM33-SUM30**2/SUM31
REDW=((SUM1-(SUM2*SUM3)/SUM4)**2)/(SUM5-(SUM2**2/SUM4))
REDT=((SUM7-(SUM8*SUM9)/SUM10)**2)/(SUM11-(SUM8**2/SUM10))
REDF=((SUM13-(SUM14*SUM15)/SUM16)**2)/(SUM17-(SUM14**2/SUM16))
REDS=((SUM28-(SUM29*SUM30)/SUM31)**2)/(SUM32-(SUM29**2/SUM31))
S2YXW=(SSYW-REDW)/(WYCNT-2)
S2YXT=(SSYT-REDT)/(TYCNT-2)
S2YXF=(SSYF-REDF)/(FYCNT-2)
S2YXS=(SSYS-REDS)/(SYCNT-2)
SYXW=S2YXW**0.5
SYXT=S2YXT**0.5
SYXF=S2YXF**0.5
SYXS=S2YXS**0.5
S2BW=S2YXW/(SUM5-(SUM2**2/SUM4))
S2BT=S2YXT/(SUM11-(SUM8**2/SUM10))

```

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REGRESSION PROGRAM--CONTINUED

```

S2BF=S2YXF/(SUM17-(SUM14**2/SUM16))
S2BS=S2YXS/(SUM32-(SUM29**2/SUM31))
SBW=S2BW**0.5
SBT=S2BT**0.5
SBF=S2BF**0.5
SBS=S2BS**0.5
TESTW=WEAN/SBW
TESTT=TYPE/SBT
TESTF=FEED/SBF
TESTS=WTAGE/SBS
FW=TESTW**2
FT=TESTT**2
FF=TESTF**2
FS=TESTS**2
TOPWT=(-1.0*(SUM19-(SUM22*SUM9/SUM10)))
ABWT=SUM25-(SUM22*SUM22/SUM10)
ABOTWT=ABWT**0.5
RBWT=SUM12-(SUM9*SUM9/SUM10)
RBOTWT=RBWT**0.5
CORWT=TOPWT/(ABOTWT*RBOTWT)
TOPWF=(SUM20-(SUM23*SUM15/SUM16))
ABWF=SUM26-(SUM23*SUM23/SUM16)
ABOTWF=ABWF**0.5
RBWF=SUM18-(SUM15*SUM15/SUM16)
RBOTWF=RBWF**0.5
CORWF=TOPWF/(ABOTWF*RBOTWF)
TOPWS=(SUM37-(SUM38*SUM30/SUM31))
ABWS=SUM39-(SUM38*SUM38/SUM31)
ABOTWS=ABWS**0.5
RBWS=SUM33-(SUM30*SUM30/SUM31)
RBOTWS=RBWS**0.5
CORWS=TOPWS/(ABOTWS*RBOTWS)
TOPTF=(-1.0*(SUM21-(SUM9*SUM24/SUM10)))
ABTF=SUM12-(SUM9*SUM9/SUM10)
ABOTTF=ABTF**0.5
RBTF=SUM27-(SUM24*SUM24/SUM10)
RBOTTF=RBTF**0.5
CORTF=TOPTF/(ABOTTF*RBOTTF)
TOPTS=(-1.0*(SUM40-(SUM42*SUM9/SUM10)))
ABTS=SUM12-(SUM9*SUM9/SUM10)
ABOTTS=ABTS**0.5
RBTS=SUM41-(SUM42*SUM42/SUM10)
RBOTTS=RBTS**0.5
CORTS=TOPTS/(ABOTTS*RBOTTS)
TOPFS=(SUM43-(SUM44*SUM30/SUM31))

```

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REGRESSION PROGRAM--CONTINUED

```

ABFS=SUM45-(SUM44*SUM44/SUM31)
ABOTFS=ABFS**0.5
RBFS=SUM33-(SUM30*SUM30/SUM31)
RBOTFS=RBFS**0.5
CORFS=TOPFS/(ABOTFS*RBOTFS)
WRITE(6,300)WEAN,TYPE,FEED,WTAGE
300 FORMAT(' ',11X,'WEAN =',F7.3,2X,'TYPE =',F7.3,2X,'FEED =',F7.3,
12X,'WTAGE =',F7.3,/)
WRITE(6,990)SSYW,SSYT,SSYF,SSYS
990 FORMAT(' ',5X,4(F7.3,5X),/)
WRITE(6,991)REDW,REDT,REDF,REDS
991 FORMAT(' ',5X,4(F7.3,5X),/)
WRITE(6,992)S2YXW,S2YXT,S2YXF,S2YXS
992 FORMAT(' ',5X,4(F7.3,5X),/)
WRITE(6,993)SYXW,SYXT,SYXF,SYXS
993 FORMAT(' ',5X,4(F7.3,5X),/)
WRITE(6,994)S2BW,S2BT,S2BF,S2BS
994 FORMAT(' ',5X,4(F7.3,5X),/)
WRITE(6,995)TESTW,TESTT,TESTF,TESTS
995 FORMAT(' ',5X,4(F7.3,5X),/)
WRITE(6,996)CORWT,CORWF,CORTF,CORFS,CORWS,CORTS
996 FORMAT(' ',5X,6(F7.3,5X),/)
WRITE(6,997)FW,FT,FF,FS
997 FORMAT(' ',5X,4(F7.3,5X),/)
WRITE(6,998)SBW,SBT,SBF,SBS
998 FORMAT(' ',5X,4(F7.3,5X),/)
IF(KEND.EQ.0) GO TO 400
IF(ICOUNT.NE.5) GO TO 20
JCOUNT=JCOUNT+1
IF(JCOUNT.GT.9) GO TO 333
WRITE(6,331)JCOUNT
331 FORMAT('1',//,38X,'( ',I1,')')
GO TO 336
333 WRITE(6,332)JCOUNT
332 FORMAT('1',//,38X,'( ',I2,')')
336 WRITE(6,337)
337 FORMAT(' ',//,34X,'APPENDIX B--CONTINUED')
WRITE(6,325)
325 FORMAT('0',//,12X,'HERD SEX YEAR WNUM WAVE AWAVE TNUM TAVE FNUM',
11X,'FAVE SNUM AWDA',/)
ICOUNT=1
20 JSEX=ISEX
JERD=IERD
WYCNT=0
SUM1=0

```


REGRESSION PROGRAM--CONTINUED

SUM2=0
SUM3=0
SUM4=0
SUM5=0
SUM6=0
TYCNT=0
SUM7=0
SUM8=0
SUM9=0
SUM10=0
SUM11=0
SUM12=0
FYCNT=0
SUM13=0
SUM14=0
SUM15=0
SUM16=0
SUM17=0
SUM18=0
SUM19=0
SUM20=0
SUM21=0
SUM22=0
SUM23=0
SUM24=0
SUM25=0
SUM26=0
SUM27=0
SYCNT=0
SUM28=0
SUM29=0
SUM30=0
SUM31=0
SUM32=0
SUM33=0
SUM34=0
SUM35=0
SUM36=0
SUM37=0
SUM38=0
SUM39=0
SUM40=0
SUM41=0
SUM42=0
SUM43=0



REGRESSION PROGRAM--CONTINUED

```

SUM44=0
SUM45=0
10 JYEAR=IYEAR
WRITE(6,350) JERD,JSEX,JYEAR,WNUM,WAVE,AWAVE,TNUM,TAVE,
1 FNUM,FAVE,SNUM,AWDA
350 FORMAT(' ',11X,A4,2X,A1,2I5,2F6.2,3(I4,F6.2))
YEAR=IYEAR-59
WYCNT=WYCNT+1
SUM1=WNUM*YEAR*WAVE+SUM1
SUM2=WNUM*YEAR+SUM2
SUM3=WNUM*WAVE+SUM3
SUM4=WNUM+SUM4
SUM5=WNUM*YEAR*YEAR+SUM5
SUM6=WNUM*WAVE*WAVE+SUM6
IF(TNUM.EQ.0.0) GO TO 101
TYCNT=TYCNT+1
SUM7=TNUM*YEAR*TAVE+SUM7
SUM8=TNUM*YEAR+SUM8
SUM9=TNUM*TAVE+SUM9
SUM10=TNUM+SUM10
SUM11=TNUM*YEAR*YEAR+SUM11
SUM12=TNUM*TAVE*TAVE+SUM12
SUM19=TNUM*WAVE*TAVE+SUM19
SUM21=TNUM*TAVE*FAVE+SUM21
SUM22=TNUM*WAVE+SUM22
SUM24=TNUM*FAVE+SUM24
SUM25=TNUM*WAVE*WAVE+SUM25
SUM27=TNUM*FAVE*FAVE+SUM27
SUM40=TNUM*TAVE*AWDA+SUM40
SUM41=TNUM*AWDA*AWDA+SUM41
SUM42=TNUM*AWDA+SUM42
101 IF(FNUM.EQ.0.0) GO TO 102
FYCNT=FYCNT+1
SUM13=FNUM*YEAR*FAVE+SUM13
SUM14=FNUM*YEAR+SUM14
SUM15=FNUM*FAVE+SUM15
SUM16=FNUM+SUM16
SUM17=FNUM*YEAR*YEAR+SUM17
SUM18=FNUM*FAVE*FAVE+SUM18
SUM20=FNUM*WAVE*FAVE+SUM20
SUM23=FNUM*WAVE+SUM23
SUM26=FNUM*WAVE*WAVE+SUM26
SUM34=FNUM*AWDA*FAVE+SUM34
SUM35=FNUM*AWDA+SUM35
SUM36=FNUM*AWDA*AWDA+SUM36

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REGRESSION PROGRAM--CONTINUED

```
102 IF(SNUM.EQ.0.0) GO TO 100
    SYCNT=SYCNT+1
    SUM28=SNUM*YEAR*AWDA+SUM28
    SUM29=SNUM*YEAR+SUM29
    SUM30=SNUM*AWDA+SUM30
    SUM31=SNUM+SUM31
    SUM32=SNUM*YEAR*YEAR+SUM32
    SUM33=SNUM*AWDA*AWDA+SUM33
    SUM37=SNUM*WAVE*AWDA+SUM37
    SUM38=SNUM*WAVE+SUM38
    SUM39=SNUM*WAVE*WAVE+SUM39
    SUM43=SNUM*FAVE*AWDA+SUM43
    SUM44=SNUM*FAVE+SUM44
    SUM45=SNUM*FAVE*FAVE+SUM45
    GO TO 100
400 WRITE(6,450)
450 FORMAT(' ',//,12X,'LAST HERD WRANGLER')
    STOP
    END
```

U OF A JOB STATISTICS = 0.46 MINUTES EXECUTION TIME

B29959